

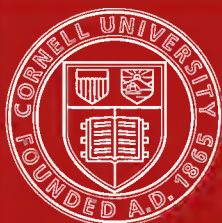
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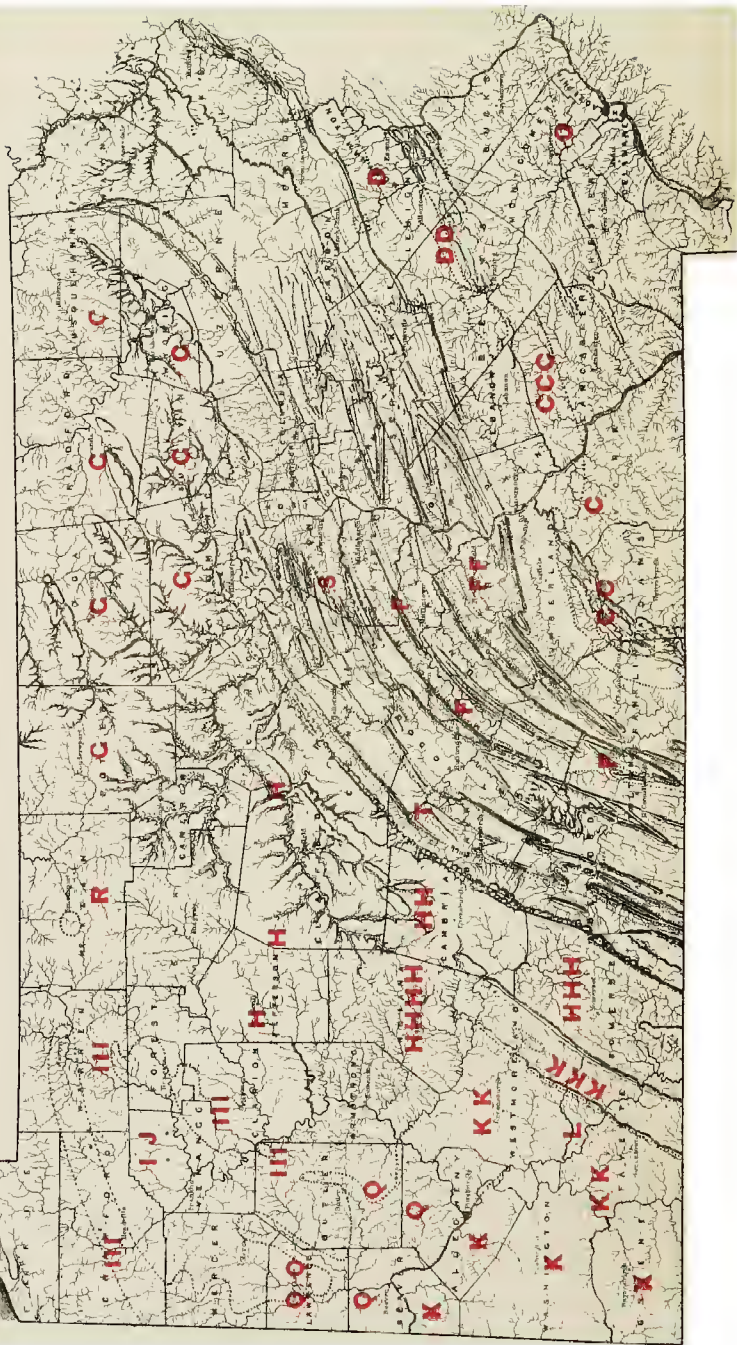
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MAP OF PENNSYLVANIA, SHOWING THE AREAS SURVEYED IN 1874, 1875, 1876 & 1877.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
1874.

REPORT OF PROGRESS
ON THE
BROWN HEMATITE ORE RANGES
OF
LEHIGH COUNTY

WITH A
DESCRIPTION OF THE MINES
LYING BETWEEN
EMAUS, ALBURTIS AND FOGELSVILLE.

By FREDERICK PRIME, Jr.,
ASSISTANT GEOLOGIST.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1875.

A. 998.
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LAFAYETTE COLLEGE, EASTON, PA., }
December 31, 1874.

Prof. J. P. LESLEY,

State Geologist:

SIR:—Herewith I present to you the report of the work done in the Lehigh District during 1874.

Owing to the lateness of the season when fieldwork was commenced, the small size of the party, and the absence of suitable instruments until almost the close of the work, it was impossible to cover as much ground as had been anticipated. Almost the whole of the time has been spent in an examination of the Brown Hematite ores of Lehigh county; merely those portions of the primary rocks and the slates having been examined which immediately adjoined the limestone. The whole of the topographical work has been done by my aid, Mr. Ellis Clark, Jr., and the accompanying map shows the care and skill with which he has accomplished his task.

Mr. Joseph R. Shimer, my Assistant in the College, rendered me much valuable assistance during the summer, being constantly employed in the field; and since then has been engaged in analytical work.

Mr. Richard J. Fogel acted as rodman towards the close of the season, and was of great use to me in my visits to the different mines.

I desire to acknowledge the obligations I am under to Robert H. Sayre, Esq., General Superintendent and Engineer of the Lehigh Valley railroad; William Lorenz, Esq., Chief Engineer of the Philadelphia and Reading railroad; Mr. Robert H. Fogel, of Fogelsville; Mr. J. W. Mickley, of Hokendauqua; the Faculty of Lafayette College, and many others, for assistance rendered on various occasions.

Yours respectfully,

FREDERICK PRIME, JR.

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REPORT OF PROGRESS
IN THE
LEHIGH IRON ORE DISTRICT,
1874.

BY FREDERICK PRIME, JR., A. G.

CHAPTER I.

Topography and Geology of the District.

If we look at any good map of Pennsylvania our eyes will at once be struck with a long mountain range, called the Kittatinny, or Blue Mountain, which, commencing at the Delaware Water Gap pursues its course entirely across the State into Maryland. From the Delaware to the Susquehanna, a distance of 104 miles, the course of the range is a pretty uniform one of S. 25° W. Then for thirty miles the direction changes to S. 81° W., after which the mountain curves and takes again almost its old direction, until it passes out of the State. At intervals along its course the mountain is five times broken through by rivers, viz: at the Delaware, Lehigh, Schuylkill, Swatara and Susquehanna Water Gaps.

Peculiar curves in the mountain at several points show where anticlinals in the rocks occur, which pass diagonally through it, from East to West, into the valleys behind. Of these there is one at the Delaware Water Gap, one at the Wind Gap and ten at the Schuylkill Gap.

The rocky crest of the range, which is 1,600 feet above tide at the Delaware, continues as an even horizontal ridge along its entire course, being here and there interrupted by small gaps. Although the actual elevation of the crest above tide-water remains the same, yet its apparent height diminishes towards the West owing to the elevation of the rolling surface of the valley in front of it, to the South.

This valley, called the Great or Kittatinny or Lebanon or Cumberland Valley, enclosed between the Kittatinny or Blue Moun-

tain, and the South or Lehigh Mountain, and consisting topographically of an undulating country, with hills (in the district to be described) only 100 to 200 feet high, extends lengthwise for a thousand miles, from Canada to Alabama, in an unbroken line.

With a single exception it is everywhere shut off from the Atlantic Seaboard by ranges of mountains which bear the respective names of Highlands, South Mountain, Blue Ridge, Smoky and Unaka Mountains.

The exception just mentioned is in Pennsylvania. To the west of Reading the South Mountain disappears for a distance of 60 miles, allowing the limestones of the valley to spread out southward over Lancaster county. Yet the rocks composing the South Mountain only disappear from the surface. After taking a plunge under the great area of limestone, and re-appearing at Millbaugh Hill, they again sink down, not to show themselves until they have crossed the Susquehanna.

The geological formations of the Great Valley are all of Lower Silurian age. The oldest ones, those which lie against the north flank of the South Mountain, belong to the Potsdam Epoch. They are composed of slates and a massive sandstone, which is changed to quartzite by the metamorphic action it has undergone, but whose geological position may be recognized by a characteristic fossil, the *Scolithus linearis*.*

Above the Potsdam sandstone or quartzite (No. I) occur the Lower Silurian magnesian limestones of the Canadian Period, (as Dana calls it,) corresponding to the Calciferous sand-rock and Chazy limestone of the New York geologists; and to the Magnesian Limestone and Saccharoidal Sandstone Formation of Missouri. In the limestone valleys of Central Pennsylvania this formation (No. II) is very thick and can be subdivided into distinct members; but in the Great Valley no such subdivision has yet been made. No fossils have, as yet, been found to guide us, and the contortions and faultings of the strata offer great obstacles to such an investigation.

These rocks (with those of the Trenton period next in order) form a belt of country along the southern side of the Great Valley, in Lehigh county, but spread more widely in Lebanon, Cumberland and Franklin, so as to occupy half of its breadth.

* Supposed to be the cast of a worm-burrow in sand.

They are, for the most part, massive semi-crystalline and compact dolomites, (magnesian limestones,) separated by one or more beds of damourite slate intercalated between them. In many places this slate has become altered to a white or yellow clay, closely resembling kaolin; and with these slates and clays the brown hematite ores, which characterize this district, are intimately associated.

The dolomite rock, or magnesian limestone itself, is almost universally colored blue or gray, a fact due to the carbon it contains;* chert and minute crystals of iron pyrites are common in it. Crystals of quartz also occur in it.

Receding from the South Mountain still further towards the middle line of the valley, the next formation met with and overlying the dolomite is the *Trenton* or *fossiliferous limestone*, which however, seems to occur only at a few points in the valley; in fact, it has been certainly recognized thus far only in Northampton county by means of certain well known fossils; but no subdivision of the formation under its New York names of Birdseye, Black River and Trenton limestones, has hitherto been possible.

The *Utica Black Slate* comes next in order upwards, overlying the Trenton along the middle line of the valley. But it is very thin in this district, and has been recognized by its color (due to graphite) only at a few places. In the limestone valleys of middle Pennsylvania it is a thick formation, and makes a continuous belt.

The *Hudson River Slate Formation* (No. III) occupies all the rest of the valley to the foot of the North, Blue or Kittatinny Mountain, and more than half way up its flank. These slates, in the absence of the Utica and Trenton, lie directly upon the dolomite rocks in this district; but so great has been the disturbance in the stratification in some parts of the valley, that the limestone sometimes seems to lie upon the slate.

The *Hudson River slates* are of great economic importance. They stretch in a broad, unbroken belt from the edge of the limestone to the base of the Kittatinny Mountains and accompany this range from the Delaware to Maryland. The lower portion of this formation is in places composed of hydraulic limestone from which valuable cement is made.

* If the dolomite is dissolved in hydrochloric acid, it will leave a residue of black carbonaceous matter.

The Sandstone of the North Mountain is Formation No. IV.

The nature of the rocks composing the South Mountain has not yet been fully ascertained; for although there is a large body of gneiss, belonging to the Archæan Period, on the flanks of the mountain, yet the central ridge or backbone is composed of rocks whose character is still somewhat doubtful. Magnetic iron ore occurs to a certain extent in this range, but how much there is of it must remain an open question until a thorough survey of the mountain has been made. It would seem as if there must be much more ore than has yet been discovered, as this mountain forms a portion of the great range which extends from Labrador to Alabama and is elsewhere so rich in iron ore.

The district to the South of these mountains consists of an undulating plain composed in its northern section of red sandstone, or the clay resulting from its decomposition, belonging to the Triassic Period, and sometimes called the *New Red Sandstone*. This covers Bucks, Montgomery, Lebanon and parts of Dauphin and Lancaster counties and extends through York and Adams, into Maryland and Virginia.

The red sandstone has been frequently broken through by eruptions of trap, which have in many cases formed hills—generally conical in shape—the most prominent being Haycock Hill in Bucks county. In some places these eruptions have apparently brought the underlying Magnesian limestone very near to the surface.

It is well known that sandstones and conglomerates are indications of shallow water, limestones of water of such a depth that marine animals can live in it undisturbed, and slates or shales of a retreating sea. What then was the case in this district of Pennsylvania?

In the Great Valley on top of the metamorphic rocks of the South Mountains, belonging to the Archæan Period, first occurs Potsdam sandstone, indicating shoal water and thence the constant attrition of the rocks composing it, subjected as they were to the rolling, wearing action of the waves. Gradually the bed of the great interior Appalachian Sea subsided, and as it did so the bottom, no longer being subject to the action of the waves, permitted organisms to live there, which, by their subsequent decay, gave rise to the limestone; their shells forming the carbonates

of lime and magnesia, the organic body yielding the carbon by which the limestones are colored. The subsidence must have been a steady, yet slow one, much like that of coral reefs, as the animals must, for a long period, have continued to exist in order to form such a thick bed of limestone. Then the conditions changed; for the limestone, instead of continuing an offshore deposit* as it had been, became changed to an open-sea deposit giving rise to the Trenton limestone, full of marine organisms. In this respect it offers a great contrast to the Magnesian limestone in which scarcely any fossils have been found in the Great Valley. But the Trenton Epoch did not last long, for the sea commenced its retreat, giving rise to slates, shales and impure limestones, thus forming the *Utica and Hudson River slates*.—With these rocks the geological record of the Great Valley ends and we find ourselves in the Kittatinny Mountain.

If we return to the metamorphic rocks of the South Mountain, we are unable to say under what conditions they were formed, as they have been so altered or metamorphosed by heat and the pressure of superincumbent rocks since their deposition, that it becomes impossible to recognize their original character.

CHAPTER II.

Potsdam Sandstone (No. I) in Lehigh County.

The South or Lehigh Mountain, and all the hills lying to the north of it, were formed long subsequent to the deposition of the Potsdam and Calcareous rocks, possibly even during the Permian Period. As a proof of this, Potsdam and Calcareous rocks (the latter containing small quantities of brown hematite ore) are found forming small basins in the interior depressions of the mountain-range. One such basin occurs near St. Peter's church.

As the contraction of the globe proceeded, by which the South Mountain range was elevated, other parallel elevations took place further north in Middle Pennsylvania, crimping the strata into anticlinal and synclinal waves, some of them miles in height, others minute and local. Since the Coal Era these have been washed away, leaving the present mountains and valleys to represent the upturned edges of the harder and softer formations.

* See Newberry in Proc. Am. Assoc. 1873. P. 196.

The lesser complications remain as rolls in the rocks at the present surface.

The Archæan rocks of the South Mountain do not form a straight line, nor is the present condition of this range the same as when first elevated. The sides of the mountain were then covered with Potsdam and Calciferous rocks, which have, in many places, disappeared under the levelling influence of air and water; which acting for ages on the rocks have, in a great measure, lowered the high ridges which were probably thousands of feet higher than they now are, and carrying the detritus into the valleys, have partially filled them up.

The backbone or central mass of the mountain, where it has been examined in Lehigh county, consists of a pyroxenic rock composed of sahlite and orthoclase, with probably small quantities of albite or some other triclinic feldspar. In appearance it resembles hyposyenite, but differs from it in containing sahlite in the place of hornblende.

A sample of the sahlite and orthoclase from the footwall of the Philadelphia and Reading Coal and Iron Company's Mine near Siesholtzville, Berks county, was analyzed with the following result:

I. Pyroxene; analyzed by Mr. Sydney Castle.

II. Orthoclase; analyzed by Dr. W. P. Headden.

	I.	II.
Silica, - - - - -	49.30	66.86
Ferric oxide, - - - - -	0.53	—
Alumina, - - - - -	14.98	18.97
Ferrous oxide, - - - - -	6.02	0.62
Magnesia, - - - - -	8.27	trace.
Lime, - - - - -	21.45	1.41
Soda, - - - - -	—	3.61
Potash, - - - - -	—	10.04
	100.55	101.51

The northern edge of the mountain-range is an irregular one; forming at times long arms which stretch out into the valleys, or else insulated islands; at times coves, up which the Silurian rocks extend, like bays filled by an arm of the sea.

Where examined in Lehigh county, the northern flank of the

main range consists of the ordinary typical gneiss—composed of dark colored mica, feldspar and quartz—overlying the pyroxenic rock. Nowhere on the northern flank of the main range, within the district surveyed were either sandstone or limestone to be seen in place, gneiss cropped out everywhere to the surface. This statement is made, however, liable to later modification, as this position of the district was examined very hastily and *superficially*. Nor is it true of every part of the mountain range, for Potsdam Sandstone is seen flanking the mountain along the Lehigh River almost the entire distance between Emaus and Bethlehem, and in the same geological position in Berks county.

The sand of which the Potsdam sandstone originally consisted has, everywhere in the Kittatinny Valley, been altered to a hard compact quartzite, sometimes white, sometimes blue, sometimes of a brownish hue; the latter due to a little ferric oxide. The quartzite does not consist of pure silica, but contains nodules of feldspar, which are unaltered where fresh pieces are obtained, but have been changed to kaolin where weathered. In many cases the kaolin has entirely disappeared, leaving very small cavities, which impart a pock-marked appearance to the rock. On Lock Ridge the sandstone covers the whole northern flank, being in turn overlaid by limestone. On the same ridge specimens of *Scolithus linearis* occur in the quartzite in great abundance.

CHAPTER III.

Magnesian Limestone Formation (No. II,) and Brown Hematite (Limonite) Ores in Lehigh County.

Overlying the Potsdam sandstone there occurs a limestone, or more properly speaking a dolomite, to which the Western and New Jersey geologists have given the name of *Magnesian Limestone*. Under this name are included the *Calciferosus* sandstone, the *Chazy*, *Birdseye* and *Black River* limestones of the New York geologists.*

[*There is no little difficulty in recognizing these subdivisions of the New York Lower Silurian Limestones outside of the limits of that State. The *Calciferosus* Sandstone often contains little or no lime. It does not appear above water level on the Cincinnati uplift. Western geologists prefer to sub-

At the east end of the ridge the limestone has a westerly dip as can be seen in Smith's and Fogel's quarries. This does not last for any distance, however, as on continuing in this direction the dip soon changes to a south and south-west direction in the Fogelsville cove, while east of Smith's and Fogel's quarries it becomes south-east in direction, and so continues wherever observed, with few exceptions probably due to rolls of the limestone, until reaching Schantz's Mill north of Wescoeville.

The dolomite.

When fresh, the general appearance of the dolomite is crystalline and of a deep gray to grayish-blue color—the color being due to the animal carbon in it. It generally occurs massive and in thick beds, but these alternate with thin slaty beds; the thick beds are often thinly parted by cleavage, this latter usually south-east in its direction. Occasionally, however, the color is different, and all possible changes between a blackish blue and delicate dove color can be found. The rock can easily be scratched with a knife, and effervesces if touched with acid. Some beds of the rock contain flints thickly strewn through them. It generally contains a high percentage of silica, and weathers very rapidly.

When weathered the rock becomes dull, of a dirty gray color, disintegrated to a depth of $\frac{1}{8}$ to $\frac{1}{2}$ inch, and converted to a soft sand retaining little or no coherence. It became a matter of interest to ascertain what change, if any, the rock underwent in this process of disintegration. For this purpose two samples were taken from the base of the quarry of the Lehigh Iron Company at East Penn Junction near Allentown. No. I is the disintegrated rock; No. II the fresh rock, about one and a half inches underneath No. I. Both samples were submitted to Dr. Genth for analysis, with the following result:

Chemical change by weathering.

	I.	II.
Carbonic acid, - - - - -	44.52	46.26
Silica, - - - - -	3.08	1.12
Ferric oxide, - - - - -	1.34	0.25
Alumina, - - - - -	1.02	0.45
Ferrous oxide, - - - - -	0.67	1.21

	I.	II.
Manganous oxide, - - -	0.35	0.44
Magnesia, - - -	21.03	20.86
Lime, - - -	28.06	29.40
	100.07	99.99

These results indicate that many samples will have to be carefully selected and analyzed, in order to come to any safe conclusion; for analyses show that the dolomite varies in composition within very short distances.

The above samples were taken from below the hydromica or damourite slate occurring at the quarry. It is probable that the limestone analyzed contains less silica than the greater portion of that occurring in this valley.

As evidence of this, two other analyses of limestones from the same range are subjoined. No. I is from Ruth's Quarry, leased by the Thomas Iron Company, about one mile north of Alburdis; analyzed by Mr. H. Pemberton, Jr. This limestone is used in the Lock Ridge furnaces. No. II is from the quarry belonging to the Carbon Iron Company, near Stemton, on the Lehigh River; analyzed by Booth and Garrett. This is used in the Parryville furnaces.

	I.		II.
Silica, - - -	12.13	Silica, - - -	7.20
Carbonic acid, -	41.29	Ferric oxide and alumina, -	0.25
Alumina, -	1.18	Calcium carbonate, -	79.50
Ferrous oxide, -	0.38	Magnesium carbonate, -	13.05
Magnesia, - - -	17.97		
Lime, - - -	27.04		100.00
	99.99		

In both these cases the much larger quantity of silica than in that analyzed from the Lehigh Iron Company's quarry will be noticed. The siliceous character of the great bulk of the limestone is confirmed by the following analyses of Mr. M'Creath's:

III. From another part of same quarry as I.

IV. From another part of same quarry as I and II.

V. Mrs. Kuhn's quarry $1\frac{1}{2}$ miles north-east of Trexlertown.

VI. Frantz's quarry $1\frac{1}{2}$ miles north-east of Trexlertown.

		III.	IV.	V.	VI.
Insoluble residue, (silica,) -	-	5.650	11.260	13.490	9.240
Carbonate Calcium, -		51.920	47.890	51.603	48.630
Carbonate Magnesium, -		41.071	39.585	32.917	40.410
Sulphur, -		trace.	trace.	0.147	0.005
Phosphorus,		0.011	0.021	0.012	0.012

The damourite.

Near the base of the Magnesian limestone occurs the hydro-mica or damourite slate. As this bed is of great importance, being intercalated in the limestone and always accompanied by the brown hematite ores, numerous analyses of this slate from various localities are subjoined.

I. From Kræmlich & Lichtenwallner's mine, Fogelsville, Lehigh county: analyzed by Dr. Genth.

II. From the Thomas Iron Company's mine at Hensingerville, near Alburtis, Lehigh county: analyzed by Mr. Sydney Castle.

III. From the Lehigh Iron Company's quarry at East Penn. Junction, near Allentown: analyzed by Mr. Pedro G. Salom.

IV. From another part of the same quarry: also analyzed by Mr. Salom.

V. From Hensinger Heirs' mine at Hensingerville, leased by Allentown Iron Company: analyzed by Mr. M'Creath.

	I.	II.	III.	IV.	V.
Silica, -	49.92	45.40	59.30	39.80	63.31
Carbonic acid,	—	—	—	14.40	—
Ferric oxide, -	0.91	5.06	30.30	2.40	3.79
Alumina,	34.06	24.69		23.95	16.16
Ferrous oxide,	—	—	—	trace.	—
Magnesia, -	1.77	13.56	trace.	1.94	4.44
Lime,	0.11	trace.	trace.	9.85	0.15
Soda,	0.74	0.27	1.51	0.52	1.54
Potash,	6.94	5.85	6.24	3.34	7.56
Water, - -	6.52	4.80	4.70	6.00	2.65
Phosphoric acid,	—	—	—	—	0.102
Sulphuric acid,	—	—	—	—	0.110
	100.97	99.63	102.05	102.20	99.812

As typical damourite contains 11.77 p. c. of potash the above first four slates contain respectively 55.40; 49.70; 53.02; and 28.30 p. c. of damourite, in addition to free silica, carbonate of lime and magnesia, and ferruginous clay.

The phosphoric and sulphuric acids in V are probably due to the ore intermingled in the slate. The damourite slate has an

unctuous, soapy feel, is usually of a pale straw-yellow to yellowish white, or sometimes pink color, and has a pearly lustre. It rarely occurs in a perfectly fresh condition; except in some of the mines which are actively worked. On exposure to the weather the slate soon begins to decompose and is then converted to a soft, unctuous clay.

The Clay.

This clay is generally brown or yellow at first, but in time becomes white, by a process of leaching. The decomposition of the slate is undoubtedly due to the alkalies it contains, and this decomposition probably occurs even more rapidly when the slate *in place* is subjected to the action of acid waters than when subjected to weathering. For the purpose of comparison, analyses of two clays are here subjoined from Kræmlich & Lichtenwallner's Mine at Fogelsville, Lehigh county. They are both from the same pit where sample I of the damourite slate was obtained. No. I is a white clay, No. II a yellow clay; both analyzed by Mr. Joseph R. Shimer, assistant in Metallurgy in Lafayette College.

	I.	II.
Silica, - - - - -	72.164	64.568
Ferric oxide, - - - - -	0.990	5.637
Alumina, - - - - -	21.764	22.770
Magnesia, - - - - -	0.698	1.281
Lime, - - - - -	0.224	0.400
Soda, - - - - -	2.120	2.800
Potash, - - - - -	3.019	3.250
Water, - - - - -	4.758	4.669
	105.737	105.375

Allowing for slight variation both in composition and on account of different degrees of weathering, the first notable difference between the analyses of the fresh damourite slate and the clay is the great increase in the silica, due to the free quartz so very common in brown hematite mines. In II a great increase in the ferric oxide is also noticeable, due to intermingled ore. When, however, we come to the alkalies we notice the great loss in the percentage of potash. This proves that the decomposition of the slate to clay is due to the alkalies, which being solu-

able in water, particularly when acid, are removed, leaving the insoluble silica and alumina behind to form the clay.

The clay has the peculiar property of decrepitating when exposed to a red heat, which renders it unfit to be used around the iron furnaces.

The damourite-slate and the clay resulting from its decomposition occur widely distributed, extending from Vermont to Alabama. Until very recently it was supposed that damourite was a rare mineral confined to a few localities, and it is to Prof. James D. Dana's investigations* that we owe our knowledge of the wide distribution of the hydro-mica slates, and that many of the rocks hitherto called talcose slates are really composed of damourite. Economically they are of the greatest importance as they are almost universally accompanied by brown hematite iron ores in the Kittatinny Valley. It is highly probable that the damourite slates were essential to the formation of the large body of ore usually accompanying them; since they always underlie this and only contain it in their upper portion. So well known is this fact, that in the mines bordering the base of the South Mountain between Easton and Bethlehem the miners cease looking for ore when they strike the white clay, which they call "hill-clay," and are very careful not to penetrate it, as otherwise they would be drowned out of the mines by the water from the mountain. From this circumstance, constantly noticed during the past season, it was supposed that the slate may have acted as an impervious bed to the waters containing iron in solution, causing these last to deposit the iron in and upon the slates. More extended examinations during the next season of field-work are needed to test this hypothesis.

From the examinations thus far made, it is highly probable that the damourite slate is Rogers' Upper Primal Slate, to which he assigns a place between the Potsdam sandstone and the Magnesian limestone. At present the geological position of the slate along the base of the mountain is somewhat a matter of doubt; as at one point it has been found intercalated between limestones. Examinations at other points will have to be made to determine

* See American Journal of Science and Arts III, 4, p. 366. Dana states that the slate formerly known under the names of talcose slate, magnesia slate, nacreous shale and talcoid schist are damourite slate, and calls attention to the discovery of a similar deposit at Salm-Chateau.

whether more than one bed of this damourite slate occurs, and whether the slate in the Fogelsville is positively of a different age from that at the base of the South Mountain.

CHAPTER IV.

The Iron Ores.

The great bulk of the iron ore found in the dolomite or limestone is known under the names of Limonite or Brown Hematite. It is the hydrated ferric oxide, having the formula $2\text{Fe}_2\text{O}_3, 3\text{H}_2\text{O}$,—containing, when pure, 59.89 per cent of iron.

The ore occurs massive, earthy, botryoidal, mammillary, concretionary and occasionally stalactitic. It has a silky, often sub-metallic lustre; sometimes dull and earthy. Color of surface of fracture various shades of brown, commonly dark, and none bright; when earthy, brownish-yellow, ochre-yellow. The streak is yellowish-brown. When stalactitic it forms the *pipe-ore*, which is rather scarce. When concretionary it forms hollow spherical masses, commonly known under the name of *pot* or *bomb-shell ore*. These hollow masses commonly contain water or masses of unctuous clay; their interior surface often presents a glazed appearance, due to a very thin coating or incrustation of oxide of manganese, which imparts a nearly black varnish-like surface. Sometimes the bomb-shell ore is solid; its interior then presents a honey-combed appearance, as if from the percolation of chalybeate waters into the mass after the exterior shell had been formed. In addition to the limonite, another ore of iron is sometimes associated with it, known to mineralogists under the name of *lepidocrocite*. It occurs in scaly-fibrous or feathery columnar masses, somewhat like plumose mica. Its color is yellowish, reddish and blackish-brown. Streak brownish-yellow to ochre-yellow. Its composition is $\text{Fe}_2\text{O}_3, \text{H}_2\text{O}$, containing 62.93 per cent. of iron. It does not occur in sufficient quantity to be of any practical importance.

The great mass of the brown hematite ore occurs in small pieces which have to be separated from the inclosing gangue by washers.

In the western portion of Lehigh county the ore apparently occurs in *four* lines of outcrops, and it remains to be proved by farther explorations whether there are one or two more lines or whether the mines which lie to the North and South and are outside of these lines actually belong to the exterior lines and have only been thrown out of position by contortions of the strata. For convenience sake the mines belonging to this uncertain class will be grouped with the others.

Along the base of the South Mountain the sandstone and dolomite have a north-west dip, away from the range, except where the dip has been reversed by outlying peninsulars of the mountain. The dip is generally 18° to 35° where the rocks are exposed any distance up the mountain-side. This dip soon changes to the south-east and almost universally remains so until close to the Hudson River slates when it frequently again changes to a north-west one and plunges under the slates.

The most southern range of brown hematite mines skirts along the North flank of Lock Ridge, and trends (like all the rest) north-east in a direction parallel to the South Mountain. The mines all have a north-west dip, like the rocks underlying them. Those included in this range are Wagenhorst's; Wescoc's; Aaron Hertzog's; Harry Kaiser's; Meitzler's; Ludwig, Hertzog and Liess's; Jonas Kreischmann's (two); Gaumer's; Kerschner's (two); Henry Shankweiler's; Crane Iron Co.'s; Allentown Iron Co.'s; Wiand's; Reuben Laros's; Marek's; and those at Hensingerville.

The second range of mines includes Ludwig's (two); Butz's; Yager's; Harry Kaiser's; Blank's; Smoyer's (four); Benjamin Smoyer's; J. Schmoyer's; Benjamin P. Schmoyer's; Judith Schmoyer's; T. Schmoyer's; A. Schmoyer's; Reuben Romig's (two); P. Romig's; Werner and Reinhart's; and Lauer's.

The third range of mines comprises an abandoned mine, J. Weiler's; Crane and Thomas Iron Co.'s; F. S. Lichtenwallner's; Schmoyer's; Gernart's; J. Scholl's; J. Bastian's; E. Bastian's; and F. Guth's.

In the fourth range are situated the mines belonging to F. Breinig; O. Moser; T. Breinig; N. Whitely; W. B. Fogel; H. Schwartz; A. Bortz; W. Koch; J. Grammis; Gackenbach; F. Fischer; J. and D. Smith; Haines; C. Miller; J. D. Scholl and Co.; J. Steininger; Moyer; Henry Stein; J. Laros; Levi Lichten-

wallner; Kræmlich and Lichtenwallner; and trial pits at Chapman's Station.

In this fourth range will be described F. Breinig's and those in the Fogelsville Cove, although it is still uncertain whether they properly belong here or form separate outcrops.

On account of the depressed condition of the iron trade during 1874 many of the mines were stopped owing to the low price offered for ore. In many cases it was, therefore, impossible to obtain any data or to get any description of the mines; for as soon as work in the open cuts is stopped, the sides begin to wash down, and in a very short time little or nothing can be seen, while at the same time the pit fills with water, generally to some depth, rendering access difficult or impossible.

CHAPTER V.

First Range of Mines.

Wagenhorst's Mine, No. 44.* This mine was not being worked when visited; it consists of a single excavation about 30 feet deep. Nothing could be seen there.

Wescoe's Mine, No. 43, abandoned. This consists of several pits, none of them very deep; work has long since been abandoned, due to exhaustion of the ore. A large body of white clay was observed in the bottom of the mine.

Aaron Hertzog's Mine, No. 42, abandoned. This mine has been abandoned, although the machinery is still standing. It consists of a single excavation, in which nothing could be seen.

[*The numbers attached to these names are taken from the current notes of the Surveying party, which moved irregularly over the area described in this Report of the fieldwork of 1874. They were transferred, together with the drawings of mines, roads, houses, dips, &c., directly upon the 400' sheets, and again upon the reduction sheets of 1,600' : 1", now published to accompany this report. It was inexpedient to attempt any geographical re-arrangement of the numbers, for two reasons: First, whatever arrangement might be adopted, must be spoiled by one or two oversights; and secondly, no possible means could be devised for the symmetrical interpolation of mines to be hereafter opened. Every one of the numbers may be easily found in the map, which is kept open and legible by the omission of all other names than those of villages and streams. A textual statement of the position of each mine is hardly desirable with Mr. Clark's carefully constructed map in hand.—J. P. L.]

Harry Kaiser's Mine, No. 41, leased by Mull and Hagenbuch. This mine was not being worked when visited, and nothing could be seen. A specimen of the ore was analyzed by Mr. M'Creath, and showed:—

Iron,	-	-	-	-	-	37.00
Sulphur,	-	-	-	-	-	0.035
Phosphorus,	-	-	-	-	-	0.186
Manganese,	-	-	-	-	-	3.033
Insoluble residue,	-	-	-	-	-	28.99

The fine ore contains a great deal of silica.

Meitzler's Mine, No. 84, leased by the Crane Iron Company. This mine had not been worked for some time, owing to the depression in the iron business. The excavation is about ten feet deep, and a little wash ore could be observed on the sides.

Meckley's Mine, No. 56, leased by Hagenbusch, Lehr & Co. Standing still all summer. The pit about five or six feet deep. Evidently only surface wash ore has yet been struck.

Ludwig, Hertzog and Liess's Mine, No. 32. On the road from Alburts to Millerstown, and about three-quarters of a mile from the former station. This ore occurs in seams or bands in the white clay, which has a dip of 27° N 23° W. A great deal of the ore is in lumps, especially at the present bottom of the mine, which is 20 feet. The seams of ore are not regular, but suddenly stop to make a bend, and then continue or stop altogether; and another seam will be found a foot or two lower down, and so on. There is a great deal of lump ore, and the mine is a rich one. The ore commences about 5 feet from the surface. But little flint or boulders of Potsdam sandstone could be observed in this mine. The present daily capacity of the mine is 20 tons; 20 men are employed.

Jonas Kreischmann's Mine, No. 33, leased by Allentown Rolling Mill Company. This mine is only separated by a fence from the preceding one, and must be identical in its characteristics. The mine was not worked during the past season.

This ore, when analyzed by Mr. M'Creath, gave the following results:—

Iron,	-	-	-	-	-	-	32.70
Manganese,	-	-	-	-	-	-	0.374

Sulphur,	-	-	-	-	-	0.030
Phosphorus,	-	-	-	-	-	0.179
Insoluble residue,	-	-	-	-	-	39.05

This ore is very siliceous.

Jonas Kreischmann's Mine, No. 34, leased by Coleraine Iron Company. This mine is about 6 to 8 feet deep. The ore is apparently disintegrated in place or surface ore. It occurs in thin streaks in a yellow clay soil with considerable flint. When visited the mine did not look very favorably. A shaft had been sunk about 18 feet, and no ore was apparent on the dump. The foreman told me that limestone was struck at a depth of 15 to 20 feet. In another part of the mine a shaft was down 30 feet and there was but little ore in the clay on the dump. In the northern portion of the mine limestone crops out, having apparently a south-east dip. The present capacity of the mine is 15 tons daily; 18 men and 3 boys are employed.

Mr. M'Creath analyzed a specimen of the ore from this mine, and found—

Iron,	-	-	-	-	-	46.60
Manganese,	-	-	-	-	-	0.454
Sulphur,	-	-	-	-	-	0.027
Phosphorus,	-	-	-	-	-	0.597
Insoluble residue,	-	-	-	-	-	16.23

Gaumer's Mine, No. 77, leased by Temple Iron Company. Not worked when visited; could not see anything, or obtain any information about it. The mine is 10 to 15 feet deep.

Kerschner's Mine, No. 75, leased by Coleraine Iron Company. The mine is about 30 feet deep. The ore forms strings and seams in clay, and fills up irregular cavities in it. The clay seems to have a dip of 10° S. 25° E. The mine presents a good appearance; there being but little flint or quartzite boulders mingled with the clay or ore. The present daily yield of the mine is 10 tons; 10 men and boys are employed.

Kerschner's Mine, No. 76, leased by Temple Iron Company. The ore occurs in thin streaks in the clay, and the mine seems to be a good one. There is a good deal of yellow clay on the top, containing no ore, from which bricks are made. The yield of the mine is from 10 to 15 tons daily; 18 men and boys are employed.

Henry Shankweiler's Mine, No. 91, leased by John Shaefer. There are two openings at this mine; neither of which has been worked since the panic. The sides were so washed that it was impossible to see anything. The ore apparently occurs associated with the ordinary yellow clay resulting from the decomposition of limestone.

Crane Iron Company's Mine, No. 72, at the junction of the road from New Texas to Emaus, and Millerstown to Allentown. The most western of the three openings belonging to this company was not worked, and nothing could be observed.

The middle mine at the north corner of the junction of the two roads was being worked. It has been excavated to a depth of 40 feet, and the regular bed of ore is still at the bottom; there being more an appearance of disintegrated or drift ore near the surface. The ore occurs, as usual on this range, with clay. But little pot or bomb-shell ore was observed. About 20 tons of washed ore are obtained here daily; 14 men and boys are employed.

The third mine belonging to the Crane Company lies at the eastern corner of the cross-roads, and was abandoned; nothing could be seen there.

Allentown Iron Company's Mine, No. 73, at the western junction of the cross-roads. This mine had been formerly worked to an inconsiderable depth on the surface for ore, and abandoned as being exhausted. The Allentown Iron Company then took hold of it and sunk shafts on to the ore in place. The ore, like that in the Crane just mentioned, presents a fine appearance, forming a regular bed on the clay. The ore at these cross-roads lies deep. The trial-shafts were sunk 25 feet at this mine before striking ore in place. The daily yield of the mine is 15 to 18 tons; 14 men and boys are employed.

Wiand's Mine, No. 74, leased by the Temple Iron Company. This lies a little to the East of the last mine. It also makes a fine show, and has been worked very extensively, being now nearly exhausted unless fresh ore should be struck at a greater depth, which there is no reason to expect. The mine is about 30 to 40 feet deep. In some places limestone is struck at a depth of 25 feet, while in other parts of the mine shafts have been sunk to a depth of 50 feet before meeting it. The ore is

partly wash ore near the surface; deeper, it forms seams in the clay; occasionally pot ore occurs. In some places the mine is being worked in 7 to 9 feet of solid ore. The daily average yield of the mine is 20 tons; 12 men are employed. A plane is used for hoisting the ore. Mr. M'Creath analyzed a specimen of the ore and found:—

Iron, - - - - -	45.30
Manganese, - - - - -	0.749
Sulphur, - - - - -	0.032
Phosphorus, - - - - -	0.137
Insoluble residue, - - - - -	21.06

Reuben Laros' Mine, No. 92, leased by Hartzell and Keck. When visited it was only 8 feet deep, having been but recently opened. On the dump all the ore seems light, and looks very slaty. In the bottom of the present openings about 6 inches of a yellow (damourite?) clay can be seen, in which most of the ore apparently occurs. The mine is not yet sufficiently opened to determine its character.

P. Marck's Mine, No. 93, leased by Lehigh Iron Company. This mine has not been worked during the past season. It consists only of stripping, the mine not being worked to a greater depth than 5 feet. It is very probable the preceding mine is of the same character. Mr. M'Creath analyzed a specimen of the ore and found:—

Iron, - - - - -	46.500
Manganese, - - - - -	0.590
Sulphur, - - - - -	0.022
Phosphorus, - - - - -	0.128
Insoluble residue, - - - - -	16.300

The mines at Hensingville are all grouped together, and can indeed be regarded as one great pit, only separated by walls at different points. Trial pits have been sunk on the Maple Grove Mill property, and good ore found. An analysis by Mr. M'Creath gave—

Iron, - - - - -	33.30
Manganese, - - - - -	0.612
Sulphur, - - - - -	0.007
Phosphorus, - - - - -	.170
Insoluble residue, - - - - -	34.25

The first mine met with, an abandoned one, belonging to Peter Kline, No. 45; is on the South side of and close to the road leading West from Hensingerville. At this place damourite slate is noticed, dipping 35° S. The mine is close to the gneiss, and was worked to a depth of about 25 feet. A little ore can be seen upon the walls of the pit, but it is impossible, in its present condition, to say whether it is exhausted or not.

J. Barber and Company's Mine, No. 49. This has been worked for some time. The ore occurs underneath a blue sandy limestone and over white clay. When seen, the appearance of the pit, where worked, looked badly, there being little or no ore in sight. It was proposed to work the more southern portion of the excavation, where the indications are more promising. Work had been stopped on the mine between two visits paid to it. Ten men were employed when the mine was being worked; there is an inclined plane for hoisting the ore. A curious fact was observed here by Mr. Barber. A short time before stopping the work a number of white rounded balls, of considerable weight and various sizes, were found underneath the brown hematite ore, and above the clay. On analysis these have proved to be siderite or carbonate of iron of a very good quality and the brown hematite has in all probability been formed by the oxidation of the siderite. Unfortunately but a small quantity of the latter has been found, as it would be a capital ore for the furnaces of the Valley. Mr. M'Creath analyzed the brown hematite and found it to contain

Iron,	-	-	-	47.000
Manganese,	-	-	-	0.518
Sulphur,	-	-	-	0.030
Phosphorus,	-	-	-	0.111
Insoluble residue,	-	-	-	16.050

He also analyzed the siderite and obtained:

Ferrous oxide,	} containing 36.35 p. c. iron,	{	45.064
Ferric oxide,			1.553
Bisulphide of iron,			0.457
Oxide of manganese,	-	-	1.150
Alumina,	-	-	1.643
Lime,	-	-	0.644
Magnesia,	-	-	1.495

Carbonic acid, -	-	-	-	-	-	29.330
Phosphoric acid, .	-	-	-	-	-	0.142
Sulphuric acid, -	-	-	-	-	-	0.061
Water, -	-	-	-	-	-	0.420
Insoluble residue, -	-	-	-	-	-	17.575
						99.534

Hensingers Mines, No. 50 and 51, leased by Allentown Iron Company and Bethlehem Iron Company. These two mines are really one, being merely separated by a thin wall of clay. The Bethlehem Company were not working their pit. The ore, as in all the Hensingerville mines, occurs near the top in yellow clay; but this soon changes either to damourite slate, or to the plastic clay resulting from its decomposition. The ore occurs in seams and streaks distributed through the clay or slate. Frequently these streaks, together with the clay, change their course abruptly as if from a sliding of the clay on itself. The clay and ore dip at this mine 28° S. S. E. The ore commences about 10 feet from the surface. The mine is about 25 feet deep. At the pit leased by the Allentown Rolling Mill Company there is but a single shaft used for washing the ore.

Thomas Iron Company's Mine, No. 52. This lies alongside of the pit just mentioned as leased by the Bethlehem Iron Company. The same remark applies to this as to the previous ones that they make a very fine show of ore, the seams appearing to be regular and in great numbers. The quantity of ore is very large and a shaft sunk 75 feet from the surface in the bottom of this excavation still showed ore. This mine has a plane for the extraction of the ore.

Trial pits have been sunk in Shankweiler's lot, and a single specimen was found by Mr. M'Creath to contain—

Iron, -	-	-	-	-	-	47.90
Manganese, -	.	-	-	-	-	0.266
Sulphur, -	-	-	-	-	-	0.003
Phosphorous, -	-	-	-	-	-	0.165
Insoluble residue, -	-	-	-	-	-	11.89

Hensingers and Saul's Mine, No. 54, leased by Allentown Iron Company. This mine has two openings, but they have not been so extensively developed as those just mentioned. The position

of the ore is the same as that already described, and it appears to be of as good quality.

An analyses by Mr. M'Creath gave—

Iron,	-	-	-	25.00
Sulphur,			-	0.008
Phosphorus,		-	-	0.189
Manganese,	-		-	0.396
Insoluble residue,		-	-	48.99

Not satisfied with this new samples were taken and found to contain—

Iron,	-	-	-	-	44.600
Sulphur,			-	-	trace.
Phosphorus,	-		-	-	0.151
Manganese,		-	-	-	0.576
Insoluble residue,	-		-	-	20.340

Mickley's Mine, No. 55, leased by the Thomas Iron Company. This mine is similar to those just described.

Hensinger Heirs Farm. Trial shafts were sunk on this farm during the past season, and an abundance of pot ore was found. Some of the ore was sent to Mr. M'Creath for analyses, and he found—

Iron,	-		-	-	44.500
Manganese,		-	-	-	9.280
Sulphur,			-	-	0.019
Phosphorus,	-		-	-	0.316
Insoluble residue,	-		-	-	6.280

No mines visited during the past season made a better appearance than these around Hensingerville. The ore occurs both as pot and wash ore, and forms very regular streaks in and on top of the slates, besides occurring for a very great depth. All these facts show the great richness of the mines.

Kiefer Mine, No. 58, abandoned. This mine was formerly worked by Mr. James Lanigan, but when visited it was impossible to see anything, as the pit had been abandoned for some time.

Desh's Mine, No. 57, abandoned. This opening has been abandoned for some time, as all the ore has been extracted. There are two excavations at this point.

This range of mines continues all along the northern base of

the South Mountain to the Delaware River. In Northampton county a number of mines are worked in Williams township by the Glendon Iron Company, and private parties. As a sample of the ore, the following analyses of samples from Sampson and Sitgreaves' Mine near South Easton, are subjoined; they were made by Kenneth Robertson, Esq., Superintendent of the Keystone Iron Company.

I is from the Upper Shaft.

II is bomb-shell ore.

	I.		II.
Water, - -	12.37	- -	13.71
Silica, -	7.58	- -	3.57
Alumina, -	5.82	-	4.50
Phosphoric Acid,	0.58=0.25 p. c. Phos.,	0.56=	0.24 p. c. Phos.
Ferric oxide, -	73.14=51.2 p. c. Iron,	71.47=	50.03 p. c. Iron.
Oxide of manganese	0.44	- -	6.41
Lime, - -	0.21	-	0.00
Magnesia, - -	0.14	- -	0.00
	100.28		100.22

CHAPTER VI.

Second Range of Mines.

Ludwig's New Mine, No. 40. This mine presents a favorable appearance, and pipe ore was found here. In one place a vein of black oxide of manganese was observed 6 to 8 inches thick. Limestone occurs above the ore, but none was seen below it. By the kindness of S. M. Felton, Esq., President of the Pennsylvania Steel Works, the following analysis is published, made by Mr. M'Creath in 1874; the sample is an average of six cars:—

Water of hydration, -	6.95
Combined water,	10.75
Silica, - -	9.93
Ferric oxide, -	68.59=48.013 p. c. Iron.
Alumina, - -	2.01
Manganic oxide,	a trace.

Lime, -	-	0.270
Magnesia, -	-	1.48
Phosphoric acid, -		0.84=0.149 p. c. phosphorus.
Sulphuric acid, -		0.06=0.025 p. c. sulphur.

100.88

Butz's Mine, No. 39. At this mine the ore occurs in yellow clay, resulting from the decomposition of limestone. When examined the mine did not present a very favorable appearance, there being but little ore apparently distributed through the clay.

Ludwig's Old Mine, No. 38. In this the limestone crops out to the surface, and a vein of ore occurs above the limestone in drift clay. The ore occurs irregularly distributed in the limestone, having the appearance of pockets rather than of regular beds. The limestone is horizontal, and presents the curious appearance of having thin layers which have decomposed to an unctuous gray clay. Mr. M'Creath analyzed the ore, and obtained—

Iron, -	-	-	-	-	-	51.25
Manganese, -				-	-	0.381
Sulphur, -	-	-			-	0.016
Phosphorus, -	-	-	-			0.100
Insoluble residue, -				-	-	11.01

Jayger's Mine, No. 37. Not worked. This mine is only striping, and at a depth of 10 feet limestone is struck, which is horizontal. The limestone is blue, saccharoidal and water-worn.

Harry Kaiser's Mine, No. 36, leased by the Bethlehem Iron Co. Of the two openings worked, no ore was in sight in the western one, except a very little drift ore in the top. In the east opening one vein, about 8 inches thick, was visible in gravel forming the surface wash. The mine when visited did not present a promising appearance, but it may improve as it deepens.

Blank's Mine, No. 30, leased by Ludwig, Hertzog & Co. Drift ore occurs immediately under the sod, then a bank of clay containing no ore, and underneath this ore and yellow clay the former in thin seams. The seams of ore occur in yellow clay, having a general southerly pitch; this is, however, very irregular, and is sometimes, locally, to the west. The mine, at its deepest part, is down 32 feet. It has a daily capacity of 20

tons of ore; 19 men and boys are employed. An analysis of this ore by Mr. M'Creath, gave the following result:

Sulphur,	-	-	-	-	0.049
Phosphorus,	-	-	-	-	0.109
Manganese,	-	-	-	-	4.575
Iron,	-	-	-	-	43.00
Insoluble residue,	-	-	-	-	19.06

About half a mile north-east of this is a mine on Ruth's or Meitzler's Farm, which has been so long abandoned that nothing whatever can be seen.

Smoeyer's Mine, No. 28, is close to the Little Lehigh Creek, near the point where it is crossed by the Catasauqua and Fogelsville Railroad. The ore occurs in yellow clay, as if the rock were disintegrated in place; no seams or streaks of ore could be perceived. The mine is about 18 feet deep. There being no one there, no special information could be obtained respecting it.

Benjamin Smoyer's Mine, No. 31, leased by Shimer and Hartzell, is 10 feet deep; the ore occurs in seams in yellow clay, and has a general dip of 10° N. 24° E. Limestone was struck in the well at a depth of 60 feet. The daily yield of the mine is 15 to 18 tons of ore, 15 men and boys being employed. Just across the Millerstown-Trexlerstown road from the preceding is another mine, which was not worked when visited.

Smoeyer's Mine, No. 80, leased by Millerstown Iron Company, was being opened for the first day's work when visited, so that nothing could be seen. Several trial-pits had been sunk, and it was stated that the indications were favorable.

Smoeyer's Mine, No. 79, abandoned. This has been worked out. It contains two peaks of white clay; one of which comes almost to the surface of the ground. Alongside of these peaks or needles are great cavities, about thirty feet deep, which extend and contained the ore. The bottom of the mine seems to consist of the same white clay.

Smoeyer's Mine, No. 78, leased by Bushong & Co., which is close to the last, is about eight feet deep. In some parts of the mine limestone is struck at a depth of five to six feet, while in other parts it was twenty to twenty-five feet below the surface. The mine is scarcely at a sufficient depth to determine whether the white clay occurs under the ore. To show the

cavernous nature of the limestone it is only necessary to state that while it is struck, as just stated, in parts of the mine at a depth of five feet, the well, just alongside, was sunk forty feet before touching it.

J. Smoyer's Mine, No. 27 and 83, leased by James Weiler, was not being worked when visited.

Benjamin P. Smoyer's Mine, No. 81, is only stripping, being but ten feet deep. Where left standing white clay is visible. It was not being worked when visited.

Judith Smoyer's Mine, No. 82, leased by B. P. Smoyer, had not been worked for some time when visited, and was full of water in the bottom so as to be inaccessible.

T. Smoyer's Mine, No. 89. There are here two small openings not worked during the past season. They are close to the Little Lehigh.

K. Smoyer's Mine, No. 90, abandoned. Nothing could be seen here; but from what could be learned it did not pay to extract the ore.

A. Smoyer's Mine, No. 85, leased by Allentown Iron Co. The ore occurs in seams in clay with a little flint. As almost the whole excavation was filled with water it was impossible to see much. The dip of the clay taken at one point was 4° S. 25° E. When working, the daily production is ten tons of ore; twelve men and boys are employed.

R. Romig's Mine, No. 70, leased by the Crane Iron Co. At the junction of the road from New Texas to Emaus and Philadelphia to Mauch Chunk. When visited was only being worked by two boys. From what could be seen the ore was apparently in yellow clay. The appearance of the mine indicates disintegration in place; no seams or streaks of ore could be seen, it being irregularly distributed in small fragments throughout the mass.

P. Romig's Mine, No. 69, leased by Israel Kolb. In the field east of the previous mine are three small openings, which were not worked when visited, and where nothing could be seen.

In the field north of these and the road to Emaus are six small and one large opening, also leased by I. Kolb, which were standing idle and nothing could be seen.

Reuben Romig's Mine, No. 64, leased by Allentown Iron Co.

This lies on the Mauch Chunk road North of the last mentioned openings, and to the West of the road. The ore occurs in small pieces of wash ore, and as pot ore in yellow and drab clay, probably due to the decomposition of limestone in place. The mine at its deepest point is 36 feet deep, and no rock has been struck anywhere. The clay dips 26° S. 12° E., coinciding with the limestone dip South of it. The daily capacity of the mine is about 18 tons; 16 men and boys employed. Mr. M'Creath's analysis shows:—

Iron,	-	-	-	-	-	51.950
Manganese,	-	-	-	-	-	0.360
Sulphur,	-	-	-	-	-	trace.
Phosphorus,	-	-	-	-	-	0.106
Insoluble residue,	-	-	-	-	-	11.430

Werner and Reinhart's Mine, No. 66, leased by Allentown Iron Co. This mine is 75 feet deep, and the ore occurs in seams and streaks in yellow clay. The clay dips 21° N. 85° E., probably due to a local roll of the beds. About 15 to 18 tons of ore are obtained daily; 15 men and boys are employed. Mr. M'Creath analyzed the ore and found:—

Iron,	-	-	-	-	-	48.000—48.500
Manganese,	-	-	-	-	-	0.173—0.194
Sulphur,	-	-	-	-	-	0.032—trace.
Phosphorus,	-	-	-	-	-	0.120—0.123
Insoluble residue,	-	-	-	-	-	15.950—16.560

Milton Lauer's Mine, No. 65, leased by Carbon Iron Co. This is really but a continuation of the previous mine, being separated by a thin wall of clay. It was not worked when visited. In both of these mines about 35 feet of stripping have to be removed before reaching ore. An analysis of this ore by Mr. M'Creath gave the following result:—

Iron,	-	-	-	-	-	38.00
Sulphur,	-	-	-	-	-	0.02
Phosphorus,	-	-	-	-	-	0.108
Manganese,	-	-	-	-	-	1.484
Insoluble residue,	-	-	-	-	-	30.97

Schmidt and Ritter's Mine, No. 67. Not being worked when visited, and there was very little to be seen. The character of the mine is the same as those above.

CHAPTER VII.

Third Range of Mines.

Abandoned Mine, near Weilersville. This mine was formerly leased by the Bethlehem Iron Co. It has been abandoned for several years, and when visited nothing could be seen.

James Weiler's Mine, No. 29, abandoned, lies south of the former on the Alburtis-Trexlerstown road. It has also been abandoned for some time.

Crane and Thomas Iron Co.'s Mine, No. 23. This is close to the Trexlerstown Church and is bisected by the Catasauqua and Fogelsville Railroad. Not worked at present, and nothing could be seen there to determine the character of the deposit.

Frank S. Lichtenwallner's Mine, No. 25. Ore very gravelly and mixed with much flint. The appearance of the mine is entirely that of a surface wash of ore and gravel which has been caught in a depression of the limestone. The limestone is struck at a depth of 15 to 30 feet, the latter depth probably in a sink-hole. The limestone crops out to the surface very rapidly to the north of the mine, but never above the soil so as to obtain the dip. Naturally it is impossible to obtain any dip of the ore or gravel. The daily capacity of the mine is 12 tons; 14 men and boys are employed. Mr. M'Creath analyzed the ore with the following result:—

Iron, - - - - -	48.250
Manganese, - - - - -	0.432
Sulphur, - - - - -	0.045
Phosphorus, - - - - -	0.025
Insoluble residue, - - - - -	18.450

Smoyer's Mine, No. 26, leased by Thomas Iron Co. Is a little farther from the road than the last and about 300 yards from that mine. The appearance of the mine as to its formation is identical with that of Lichtenwallner's. It is said that limestone is struck at a depth of about 13 feet, but no exposure was

seen. The daily capacity of the mine is 10 tons ; 13 men and boys are employed.

Gernart's Mine, No. 24, leased by Crane Iron Co. This mine is but 12 feet deep, and no ore has been found below this although shafts have been sunk for that purpose. Below the ore sand is found. The appearance here is as if the ore was a mere surface wash caught in a depression of the surface. The well was sunk to a depth of 64 feet without striking rock ; it passed the whole way through sand and gravel. The number of men and boys employed is 16. At one part of the mine a streak of black oxide of manganese was observed in the top clay.

James Scholl's Mine, No. 94. This mine, but a hundred feet from the preceding one, is identical with it in character. The mine is 14 feet deep. The daily yield of the mine is 12 to 15 tons of ore ; 12 men and boys are employed.

Jonas Bastian's Mine, No. 62, abandoned. Shafts have been sunk quite a depth in the bottom of the mine ; but the stuff at the mouth of the shafts has been nearly all washed away. The mine is from 10 to 15 feet deep ; near the surface it is apparently ore disintegrated with the rock in place ; near the bottom of the mine the ore appears in one or two places to form beds in the clay.

Elwyn Bastian's Mine, No. 63, leased by the Lehigh Iron Co. The bottom of the mine was full of water, and work had been recently stopped on the mine when it was visited. The mine is 22 feet deep to water. It was impossible to make a careful examination on account of the water. Ore occurs in clay, the latter varies from level to a dip of 5° S. 18° W.

An analysis of this ore by Mr. M'Creath gave the following result :—

Iron, -	-	-	-	-	42.30
Manganese,			-	-	0.648
Sulphur, -	-	-	-	-	0.026
Phosphorus,			-	-	0.100
Insoluble residue,		-	-	-	24.12

This ore is very silicious.

Francis Guth's Mine, No. 61, leased by Carbon Iron Co. There are three excavations at this mine. It had not been worked

for some little time when visited and nothing could be seen. Mr. M'Creath analyzed the ore and found

Iron, - - - - -	48.200
Manganese, - - - - -	0.418
Sulphur, - - - - -	0.005
Phosphorus, - - - - -	0.158
Insoluble residue, - - - - -	14.810

CHAPTER VIII.

Fourth Range of Mines.

Francis Breinig's Mine, No. 17. The large pit is full of water; it has not been worked since 1860, and is said to be exhausted. To the right is a smaller opening, which is being worked at present. The ore occurs in seams and streaks in damourite slate, and the white and yellow clays formed by its decomposition. The clay and ore pitch 18° to 25° S. 80° E. The portion of the mine worked is 50 feet deep, and does not exhibit any sign of the ore being exhausted. There is a plane for hoisting the ore. The daily capacity of the mine is 20 tons of ore; 20 men and boys are employed. Mr. M'Creath analyzed the ore, and found—

Iron, - - - - -	48.100
Manganese, - - - - -	0.360
Sulphur, - - - - -	0.045
Phosphorus, - - - - -	0.164
Insoluble residue, - - - - -	13.440

In the northern portion of the field in which the mine is situated a blue ochre is obtained, which is used as a paint. It is probable that this ochre is decomposed *Utica Shale*. An analysis by Dr. Genth gave the following result:—

Loss by ignition in closed crucible, (water) -	4.84
Do. do. open crucible, (graphite,) -	4.26
Quartz, - - - - -	44.50
Combined silica, - - - - -	26.25
Alumina with traces of ferric oxide, - - - - -	17.95
Magnesia, - - - - -	0.94
Alkalies, et. cet., (not determined,) -	1.26

100 00

To the south of the large abandoned opening there are two smaller ones, also full of water. This mine lies $1\frac{1}{2}$ miles north-west of Breinigsville. The clay from the mud-dam is dried and sold as yellow ochre for the preparation of paint. Mr. M'-Creath's analysis shows it to contain—

Silica, -	-	-	60.53
Alumina, -	-	-	17.40
Ferric oxide,	-	-	9.29
Lime, -	-	-	0.08
Magnesia, -	-	-	1.92
Water, -	-	-	5.51
Alkalies (by loss,)	-	-	5.27
			100.00

Oliver Moser's Mine, No. 20, leased by the Northampton Iron Co. This mine has only recently been opened to a depth of 5 or 6 feet. The ore thus far obtained is all pipe ore. Mr. M'-Creath's analysis shows—

Iron, -	-	-	57.500
Manganese, -	-	-	0.749
Sulphur, -	-	-	trace.
Phosphorus, -	-	-	0.165
Insoluble residue,	-	-	3.470

Thomas Breinig's Mine, No. 19, leased by the Northampton Iron Co. This is one of the oldest mines in the county, having been worked more than sixty years. This is the mine described in Rogers' Final Report of Pennsylvania, Vol. I, p. 265, under the name of the "Copperas mine." The old portion of the mine is full of water, and is said to be 60 feet deep. The ore occurs above damourite slate, and associated with iron pyrites. It is improbable that the sulphuret of iron owes its origin to a small shallow bed of *Utica shale*, which has undergone disintegration. It was impossible to ascertain whether the *blue ochre* occurred here or not. The most probable explanation of the formation of the iron pyrites, which occurs as pipe-shaped stalactites is, that sulphate of iron in solution, coming in contact with organic matter, or possibly the graphite of the blue ochre, was reduced to sulphide of iron. That the sulphide of iron is not a

deposit cotemporaneous with the rock, is evident from its stalactitic character. Black oxide of manganese occurs here, but it was impossible to see any of it owing to the condition of the mine. Rogers, in his Final Report states, that it occurs in the upper portion of the ore on the West side of the mine. Mr. McCreath analyzed the ore from this mine, and obtained the following result:—

Iron, - - - - -	58.500
Manganese, - - - - -	0.223
Sulphur, - - - - -	0.084
Phosphorus, - - - - -	0.043
Insoluble residue, - - - - -	2.800

A thin bed of white saccharoidal sandstone occurs in this mine, as in Schwartz's; pieces of it were observed thrown up on the bank. Mr. Breinig states that the brown hematite occurs above and below this, but not in it. Pieces of sandstone colored red by iron were also observed on the dump. These were examined by Mr. F. A. Genth, Jr., and found to contain quartz with small quantities of a hydrous silicate of alumina and potash, evidently damourite. When visited, it was the intention to pump the mine dry, and recommence work in it; owing to the heavy pumping duty, it seems a question of grave doubt whether such an undertaking can be made remunerative. To the west of the old mine a new excavation has been recently commenced; it is not yet of a sufficient depth to determine the dip of the slate, as this has not been struck. In order to show the character of the ground, the result of borings at this mine, by Nathan Whitely, are subjoined, copied from Rogers' Final Report:

No. 1.—WEST OF PRESENT WORKINGS.	No. 2.—FURTHER WEST.	No. 3.—EASTERN BORING.
30 feet Clay and gravel.	15 feet Gravel and clay.	14 feet Clay.
4½ " Brown hematite.	1 " Iron ore.	8 " Iron ore and clay.
7½ " Clay.	15 " Clay.	9 " Iron ore.
2 " Black clay.	5 " Slate.	3 " Clay.
12 " Sulphuret of iron	6 " In clay.	2 " Copperas earth.
5 " Iron ore.	9 " Pipe ore and clay.	2 " Do. & black clay.
	4½ " Clay.	2 " Do. & white clay.
		8 " Brown clay & iron
		2 " Rock-iron ore.[ore
		8 " Clay.
Bottom of boring.	Bottom.	Bottom.

At the new opening the daily average of ore is 10 to 15 tons; 16 men and boys are employed.

Nathan Whitely's Mine, No. 21. At this mine, (about 15 feet deep,) the ore occurs in clay containing a great deal of flint. A good deal of the ore is pot or bomb-shell. Limestone crops up in the bottom at very varying depths, owing to its having been so much water-worn. From one of the limestone caverns, water bubbles up very rapidly. One of these caves when sounded with a pole was 24 feet below the present surface of the mine. In other parts of the excavation, limestone occurs at the depth of 15 feet from the surface. The ore dips 15° S. 60° E. The mud from the mud-dam, which is ochre-yellow in color, is carefully dried and then sent as ochre to the Blue Mountain Paint Company at Bethlehem.

Mr. M'Creath analyzed it and found

Insoluble residue, - - - - -	55.88
Alumina, - - - - -	19.40
Ferrie oxide, - - - - -	10.57
Lime, - - - - -	0.08
Magnesia, - - - - -	1.71
Water, - - - - -	8.17
Alkalies, - - - - -	3.76
	99.57

An analyses of the ore by Mr. M'Creath gives the following:

Insoluble residue, - - - - -	20.21
Iron, - - - - -	45.70
Manganese, - - - - -	0.648
Phosphorus, - - - - -	0.157
Sulphur, - - - - -	0.034

William B. Fogel's Mine, No. 18, leased by Carbon Iron Co. This was not being worked when visited. The ore occurs in lamourite-slate with an abundance of yellow clay. The yellow clay containing the ore occurs in seams and streaks in the white decomposed lamourite slate and clay. The dip of the slate is 14° S. 65° E. The mine is 24 feet deep at its greatest depth. A shaft has been sunk to a depth of 40 feet farther, and it was said that the best ore occurred at the bottom of the shaft. Mr. M'Creath analyzed the ore and found—

Iron, - - - - -	48.500
Manganese, ...	0.360
Sulphur, ...	0.002
Phosphorus, - - - - -	0.328
Insoluble residue, ...	15.580

Henry Schwartz's and W. B. Fogel's Mine, No. 22, leased by the Crane Iron Co. This mine is 38 feet deep, and dips 13° S. 36° E. The bottom of the mine, where worked, shows white saccharoidal sand, and a short distance above it there occurs a bed of white saccharoidal sandstone intercalated in the clay, about one inch thick. The white sand contains a little ore above this occurs yellow clay and damourite-slate, the former forming seams in the latter, which contain ore; above this occurs gravel. The upper part of the clay in and above the slate consists only of stripping, and is not washed. The ore is hoisted by a plane from the mine. Mr. M'Creath's analysis shows—

Iron, ...	51.750
Manganese, ...	0.309
Sulphur, ...	trace.
Phosphorus, ...	0.270
Insoluble residue, ...	10.350

Alwyn Bortz's Mine, No. 95, abandoned. Nothing could be seen here, the banks being thoroughly covered with surface wash.

Alwyn Bortz's Mine, No. 14, leased by Allentown Rolling Mill Co. This mine is 36 feet deep. Only yellow clay can be seen, in which the ore occurs in small pieces and as bomb-shell. The men say it is only stripping. The daily average is about 12 tons of ore; 16 men and boys are employed. Mr. M'Creath's analysis shows—

Iron, ...	49.300
Manganese, ...	0.216
Sulphur, ...	trace.
Phosphorus, ...	0.235
Insoluble residue, ...	15.120

Alwyn Bortz's and William Koch's Mine, No. 13, leased by Carbon Iron Co. This forms but a single excavation. White clay occurs here at the west side underlying the ore and having a south-east dip. The mine is 48 feet deep, and limestone is struck 8 feet below, in fact water-worn limestone occurs at west end.

The ore is said to have dipped south-east at west end; it dips north-west at south side, but being inaccessible on account of water, it was impossible to say how much. The daily yield is 30 to 35 tons; 50 men and boys are employed. There are two planes to this mine. An analysis of this ore by Mr. M'Creath shows—

Iron, ...	46.600
Manganese, ...	0.144
Sulphur, ...	trace.
Phosphorus, ...	0.276
Insoluble residue, ...	19.880

Jonas Grammis' Mine, No. 12, leased by Allentown Rolling Mill Co. This mine, which is separated from the preceding one by a thin wall of clay, is identical with it in character. The ore occurs in yellow clay above white clay. The dip of the clay is east and south-east, but irregular. The average yield of the mine is 25 tons; 25 men are employed. There is a plane in the mine.

Jonas Grammis' Mine, No. 96, not worked. This mine is 25 feet to water, but it was inaccessible, and therefore could not be examined. Mr. M'Creath analyzed the ore and found—

Iron, ...	49.000
Manganese, ...	0.187
Sulphur, ...	trace.
Phosphorus, ...	0.172
Insoluble residue, ...	15.490

In all this group of mines the seams of ore appear to be very irregular in their character, and deserve a closer examination than it was possible to give them, owing to the water in the bottom of the excavations.

Gackenbach's Mine, No. 60, leased by the Crane Iron Co. The ore occurs in this mine in yellow clay, and no damourite-slate or white clay occurs with it, so far as could be seen. The foreman states that there are two beds of ore in the mine, the upper one about 10 feet thick, which are separated by clay. Water-worn limestone was struck, in some places, at a depth of 60 feet; no ore was found under this, but in clay in depressions in it. The ore occurs in and above the clay, and not in the limestone. The mine is 72 feet deep to water, and there were about 20 feet of water in it when visited. It is impossible to keep the mine dry, even with four pumps working night and day, owing to a spring

in the bottom of the excavation. It was stated that eleven million gallons of water were pumped out every 24 hours. In order to work out the ore the experiment is being tried of cribbing the mine in the middle to a height of 38 feet; then the slime from the washer is to be dumped into the sump thus formed. It is hoped that the flow of water will be stopped in this manner, so as to permit the extraction of the ore, which, in the meantime, is to be removed from the side of the mine on the opposite side of the crib to the spring. Owing to the water in the mine it was impossible to take the dip, which was said to be 30° to 40° S. and S. E.

A portion of the ore is called "red rock ore" and appears red besides having a red streak. It is probably limonite rendered anhydrous by some local cause. When visited no ore was being extracted the whole attention of the men being turned to cribbing the bottom. The ore in the bottom is said to be very fine and almost solid. As much as 1300 tons a month have been extracted; 30 men and boys are employed. There are two planes for hoisting the ore. Mr. M'Creath's analysis of the ore gives—

Water,	-	-	-	-	10.830
Iron,	-	-	-	-	51.700
Manganese,	-	-	-	-	trace.
Sulphur,	-	-	-	-	0.214
Phosphorus,	-	-	-	-	0.066
Insoluble residue,	-	-	-	-	10.550

Francis Fischer's Mine, No. 59, leased by the Coleraine Iron Co. This mine which lies in the same range as the mines previously described, is a long distance from Gachenbach's, being separated from it by Chapperal Ridge. In this mine no rock is apparent, nor has any been struck. The ore occurs as wash and pot ore in yellow clay probably resulting from the decomposition of the limestone. At the east end the clay basins slightly, and dips 30° S. 67° E. The mine is 36 feet deep. The daily average of ore is 9 to 10 tons; 10 men and boys are employed. Mr. M'Creath analyzed the ore and found—

Iron,	-	-	-	-	45.000
Manganese,	-	-	-	-	0.626
Sulphur,	-	-	-	-	trace.
Phosphorus,	-	-	-	-	0.190
Insoluble residue,	-	-	-	-	21.900

Returning now to the Fogelsville cove of limestone the first mines are at the extremity of the slate nose forming the southern boundary of the cove.

J. and D. Smith's Mine, No. 16, leased by Millerstown Iron Co. Only the most Southern excavation is worked, it is about 30 feet deep and is only the surface stripping. The most northern opening is worked out and full of water. This is the pit described in Rogers' Final Report as *Schloug's Mine*; and from the description, there given, it is evident that the ore occurs in damourite slate and clay. 12 men and boys are employed at the new pit. Mr. M'Creath's analysis shows—

Iron,	-	-	-	-	-	-	28.100
Manganese,	-	-	-	-	-	-	5.029
Sulphur,	-	-	-	-	-	-	0.002
Phosphorus,	-	-	-	-	-	-	0.551
Insoluble residue,	-	-	-	-	-	-	36.430

Haines's Mine, No. 15, abandoned. The excavation is 20 feet deep, but has been abandoned for a long time, as there was not sufficient ore to pay for its extraction. It was impossible to see anything.

Charles Miller's Mine, No. 97, stripping. This is nothing but stripping the surface clay and ore to a depth of 2 to 4 feet. Mr. M'Creath analyzed the ore and found—

Iron,	-	-	-	-	-	-	51.40
Manganese,	-	-	-	-	-	-	0.295
Sulphur,	-	-	-	-	-	-	0.021
Phosphorus,	-	-	-	-	-	-	0.233
Insoluble residue,	-	-	-	-	-	-	11.29

Charles Miller's Mine, No. 9, abandoned. This mine has long been abandoned and is full of water, hence it is impossible to see anything. According to Rogers, in his Final Report, the ore occurred irregularly stratified, (with damourite slate?) and was covered by slaty debris to a depth of 5 to 25 feet. The bedding of the ore dipped at a moderate angle to the S. E., but at 100 yards the ore rose to the surface again and was worked at its outcrop. As the bed sank from the surface along the dip the ore became more solid; but in places the ore was replaced by bodies of clay (from the decomposition of damourite slate?)

J. D. Scholl and Co.'s Mine, No. 11, leased by Lehigh Valley Iron Co. The ore occurs very irregularly bedded in white clay, resulting from the decomposition of damourite slate. There are quite large rolls in the bedding; so that while the general average dip is 10° S. 5° E., there are local dips to the S. W. of which one is 55° S. 25° W. The mine can produce 25 tons per day; 10 men are employed at the present time. There is a plane for hoisting the ore. Mr. M'Creath analyzed the ore and found—

Iron,	-	-	-	-	-	47.000
Manganese,	-	-	-	-	-	7.464
Sulphur,	-	-	-	-	-	0.003
Phosphorus,	-	-	-	-	-	0.630
Insoluble residue,	-	-	-	-	-	4.940

Jacob Steininger's Mine, No. 8, leased by James Lanigan. This mine is 25 feet deep. The brown hematite occurs in damourite slate and overlying the white clay resulting from the decomposition of the slate. The ore and slate dip 22° to 40° S. 40° E. At the bottom of the mine at the north end there occur 12 feet of solid white clay with a thin streak of ore underneath. In the bottom of the excavation a shaft has been sunk to the depth of 18 feet, but no ore was found at a greater depth than 6 feet. The shaft then passed into clay. No ore was being extracted at the time the mine was being visited; 10 to 15 men are employed. There is a plane for hoisting the ore. An analysis of this ore by Mr. M'Creath showed the following constituents:—

Iron,	-	-	-	-	-	36.500
Manganese,	-	-	-	-	-	2.932
Sulphur,	-	-	-	-	-	0.031
Phosphorus,	-	-	-	-	-	3.135
Insoluble residue,	-	-	-	-	-	18.900

Jacob Steininger's Mine, No. 10, abandoned. This mine which has not been worked for a long time, is now exhausted, but has yielded a great deal of ore. It is about 600 feet long and 15 to 20 feet deep to the water in it. The banks have been so much washed that it is impossible to see anything on them.

Moyer's Mine, No. 6, leased by the Thomas Iron Co. This mine has been very recently opened, being but 6 feet deep, and as yet the ore is nothing but stripping in gravel.

Henry Stein's Mine, No. 5, leased by Thomas Iron Co. In

this mine no damourite slate was apparent, but the ore occurs in and over white and pink clay, resulting from the decomposition of the slate. The mine is 47 feet deep. At a depth of 40 feet limestone was struck in one portion of the mine which dips 12° S. 41° E. The top limestone is slaty and drab colored. It is 4 feet thick and overlies the ordinary blue waterworn limestone. The clay overlying the limestone and containing the ore, dips 42° in the same direction. In the limestone at the bottom of the mine there is an aperture about 10 inches square into which all the water of the mine pours and disappearing avoids the necessity of any pump to keep the mine dry. Mr. M'Creath's analysis gives—

Iron,	-	-	-	-	-	-	49.600
Manganese,	-	-	-	-	-	-	0.583
Sulphur,	-	-	-	-	-	-	0.007
Phosphorus,	-	-	-	-	-	-	1.288
Insoluble residue,	-	-	-	-	-	-	9.440

Henry Stein's Mine, No. 98, abandoned. The mine is 10 to 12 feet deep to water-level. It has not been worked for a long time, and nothing can be seen. From the large quantity of clay that has been removed, it is evident that a great deal of ore has been taken out.

Jesse Laros's Mine, No. 4, leased by the Crane Iron Co. The mine was not worked when visited, and the bottom was full of water. The depth of the mine to water is 38 feet. On the west side of the mine there is a mixture of clay, quartz and damourite-slate, all in very small pieces, for a depth of 17 feet from the surface. Larger pieces of the slate occur on the dump, showing that it occurs at a greater depth. The ore where visible, at a few points, occurs in clay. Mr. M'Creath analyzed it and found

Iron,	-	-	-	-	-	-	43.700
Manganese,	-	-	-	-	-	-	0.763
Sulphur,	-	-	-	-	-	-	0.005
Phosphorus,	-	-	-	-	-	-	0.869
Insoluble residue,	-	-	-	-	-	-	18.580

Jesse Laros's Mine, No. 3, abandoned. This excavation has not been worked for a long time. The ore, from the fragments on the side of the mine, must have been associated with damourite slate.

Levi Lichtenwallner's Mine, No. 2, leased by the Crane Iron Co. At this mine there are several excavations. The most southerly one is full of water at the bottom, and is 26 feet deep to the water. There is a plane in this pit. The small one to the north of this is only 10 feet deep; only stripping having been taken from it. The largest excavation of all lies still more to the north; this is 40 feet deep, and is no longer worked. To the west of this is a small pit 15 feet deep. The mine has not been worked since the Fall of 1873. The ore occurs in white clay, and overlying damourite-slate. In some places the clay apparently overlies the ore, but clay or slate underlies it. It is said that the well, which has been sunk to a considerable distance, struck blue slaty limestone at a depth of 130 feet. As the mine is not being worked, it was impossible to ascertain the dip. Mr. M'Creath analyzed the ore and found—

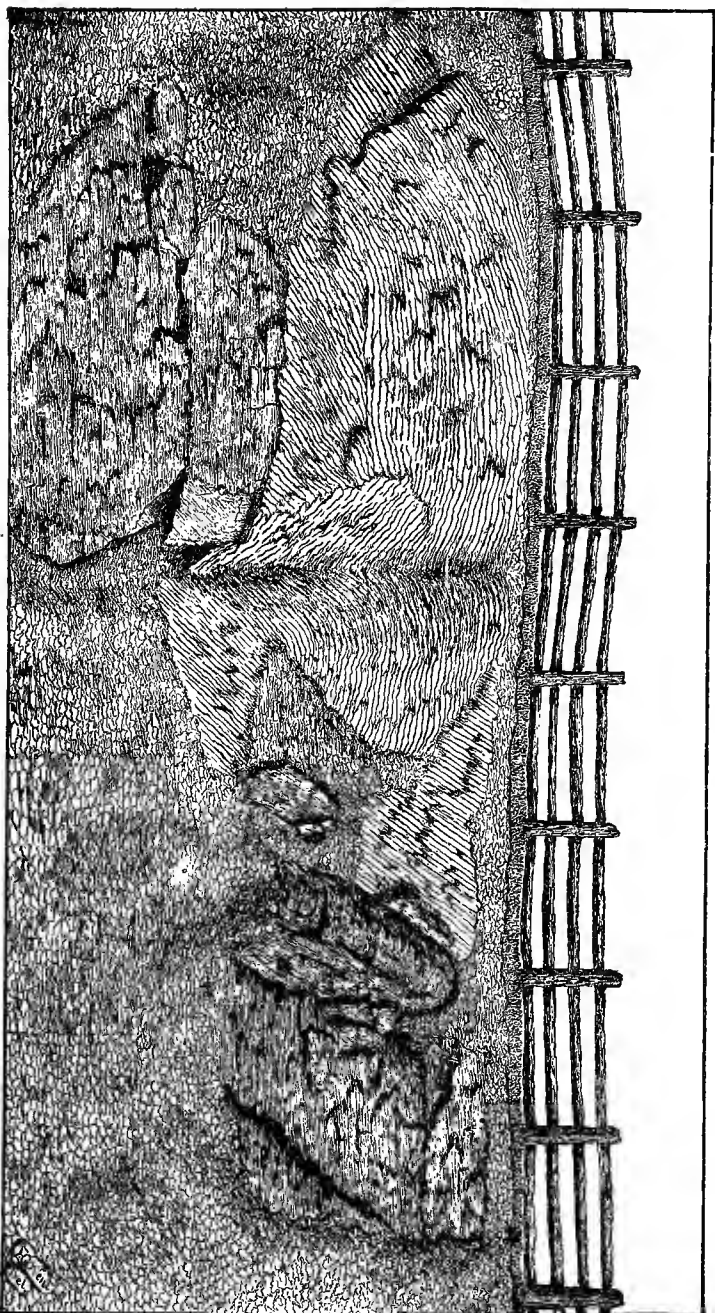
Iron, - - - - -	42.800
Manganese, - - - - -	0.252
Sulphur, - - - - -	0.036
Phosphorus, - - - - -	0.222
Insoluble residue, - - - - -	25.040

Kræmlich and Lichtenwallner's Mine, No. 7, leased by the Crane Iron Co. This mine, which is 50 feet deep, has not been worked since the Fall of 1873. A blue water worn limestone occurs in the bottom of the excavation, whose stratification is apparently horizontal. There is evidently a large quantity of damourite-slate and white clay underlying the ore, and in some places in it. As the walls of the mine are all covered with debris, it was impossible to take the dip of the slate. Pieces of sharp, angular quartz are common in the clay on the slope of the mine. A plane is used to hoist the ore. Mr. M'Creath's analysis shows—

Iron, - - - - -	50.400
Manganese, - - - - -	1.203
Sulphur, - - - - -	0.002
Phosphorus, - - - - -	0.993
Insoluble residue, - - - - -	10.050

The Thomas Iron Company have sunk a number of shafts on the Litzenberger farm (No. 1) near Chapman's Station. Ore was found distributed through the clay in all of them. In three of them

PLATE II.—JUNCTION OF LOWER SILURIAN LIMESTONES AND HUDSON RIVER SLATES 2 MILES S. W. OF FOGELSVILLE.



about 20 feet of ore was found. It seems somewhat doubtful whether the ore in sight will justify the erection of machinery. Probably no very large quantity of ore will be found.

CHAPTER IX.

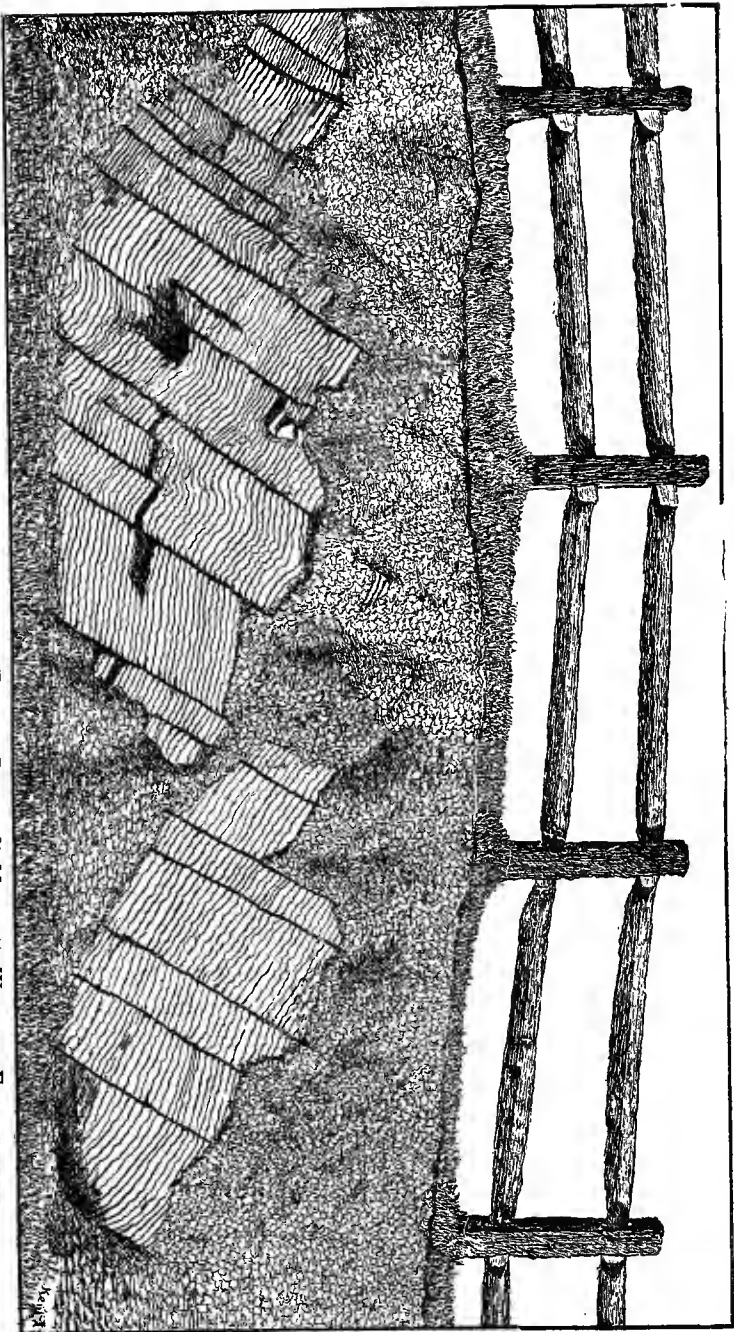
Relations of the ore to the rocks.

Before leaving this subject it seems appropriate to give a short summary of the manner in which the ore occurs. The ore occurs in two ways as Pot and Wash ore or as Pipe ore. The latter generally associated with limestone; often underneath its and presenting the appearance of having been formed by infiltration through it.

The Pot and Wash ores occur *in place* most richly when associated directly with the damourite slate or clay resulting from its decomposition. They also occur associated with the yellow clay resulting from the decomposition of the Magnesian limestone. But when associated with this the ore does not have the same regularity as when associated with the slate, and almost always large quantities of angular flint occur with it. It presents the appearance of having been washed into depressions of the limestone. It is probable that much of the ore thus found owes its present position to the destruction of the beds where it was first deposited; but not all of it, as there are instances where, after going through deposits of this kind, richer ore has been struck associated with damourite clay. The experience during the past season was that where the association of ore and clay was not met with, the mines did not continue for any great depth and were soon exhausted, as must necessarily be the case where the deposits are merely the debris of disintegrated rocks washed into cavities of the limestone.

The ore does not occur in regular beds in the damourite slate or clay, but generally forms small masses of irregular shape, which soon run out; but the separate masses are only parted by very narrow walls of slate or clay. Frequently the ore, after continuing parallel to the stratification of the slate or clay, will suddenly bend at right angles to it and after remaining thus bent for a short distance, taking another bend, will again con-

PLATE III.—STRATIFICATION AND CLEAVAGE OF HUDSON RIVER, 2½ MILES S. W. FROM FOGELSVILLE.



tinne parallel to the stratification. Sometimes the entire body of clay and ore will bend so as to form corrugated masses. "As erosion went on the oxidized iron slipped with the heavy clays slowly downwards, the whole mass pressing upon itself and crimpling as it slid."*

Sometimes the body of ore is solid, but this does not generally continue for any great distance.

Many persons have supposed that the limonite was formed by the oxidation of iron pyrites. It is to be noted as a fact rather opposed to this view, that with one exception it has been impossible, thus far, to find iron pyrites in any of the mines examined. That exception is at Thomas Breinig's mine and there the pyrite is evidently of later age than the limonite and has a stalactitic appearance. Some persons, on the other hand, have supposed that the ore was formed by the alteration of carbonate of iron, which has been found in some cases present in the limestone. Still others have supposed the ores to be the result of reactions between the limestone and ferrous sulphate.

As yet all of these theories are mere hypotheses; and before the correctness of any or all or none of them can be proved it will require a long series of chemical investigations.

CHAPTER X.

Hudson River Slates in Lehigh County.

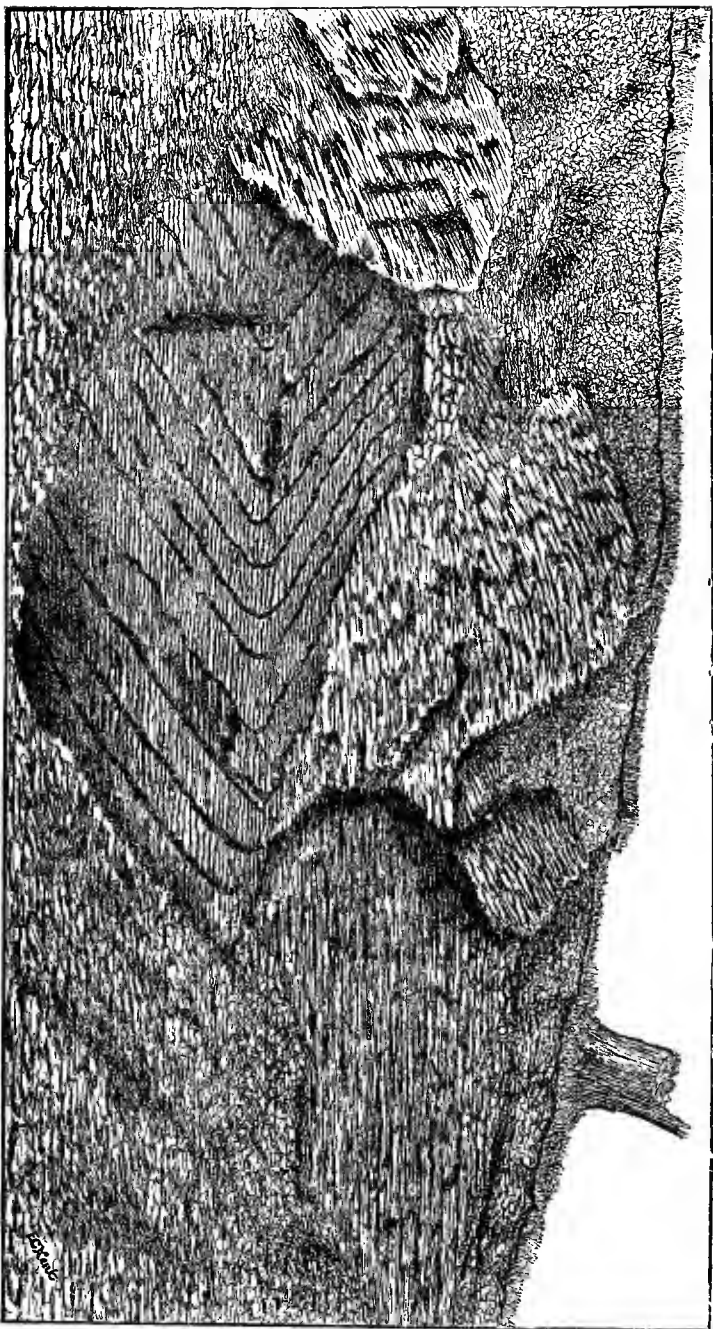
The *Trenton* or *Fossiliferous* limestone is absent in that portion of Lehigh county which was examined. It is, however, probable that the *Utica shale* is present. The evidence in its favor being the presence of so-called "blue ochre" at Francis and Thomas Breinig's mines. It was not seen at any other point, although carefully looked for.

The Hudson River slates constitute a very thick formation, as their outcrops occupy the whole interval between the northern edge of the Magnesian limestone and the Kittatinny mountain.

The slate varies from bluish-gray to almost black, and is at times sandy. In some localities it is extensively quarried for roofing and

*See Prof. Lesley in Proc. Am. Phil. Soc., 1873, on The Iron Ores of the South Mountain.

PLATE IV.—OVERTURNED ANTICLINAL IN HUDSON RIVER SLATES NEAR FOGELSVILLE.



other purposes. During the past season it was only examined incidentally where its base came in contact with the Magnesian limestone.

The approximate line of contact between the slate and limestone is very marked, being defined by the transition from the rolling country of the limestone to the smooth, rounded, dome-shaped hills of the slate in which are narrow, deep valleys worn by the streams coursing through them.

The first point where the slate was met during the past season was in the nose which forms the Fogelsville cove of limestone. This nose, which rises about 200 feet above the surrounding limestone country, forms a distinct synclinal, which could not be traced eastward through the limestone with satisfactory distinctness. At one point on a road across the ridge, north of Breinigs-ville, there is a slate outcrop on Francis Breinig's farm, in which the dip and cleavage vary; the former being 45° to 57° N. W., while the latter is 39° to 47° S. E. A sketch of this is given on Plate 2.

On the north side of the ridge a slate quarry has been opened on Jacob Steininger's farm. The slate on the dump does not appear to be of first quality. The quarry is no longer worked, and is full of water, so that it is impossible to ascertain the true dip, which is apparently south-east. At the south-west corner of the Fogelsville cove, the contact of the slate and limestone may be observed in an abandoned limestone quarry belonging to Henry Stein. (See Plate 3.)

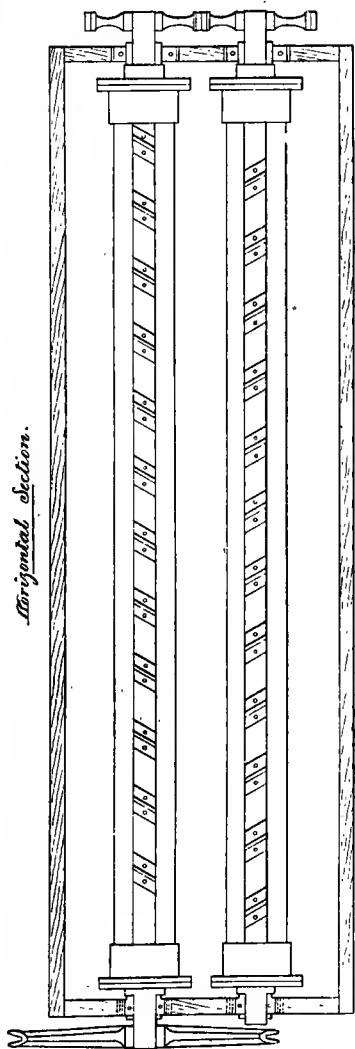
The dip of the two rocks here do not coincide; that of the limestone is 11° to 14° S. 22° W., while that of the slate is from 10° to 58° S. 32° E. The latter is rotten and much broken up. The slate bounds the west side of the Fogelsville cove, and then turning forms also the northern boundary. At one point near the road running along the base of the slate on Lichtenwallner's farm the slate is apparently overturned, and shows a beautiful rounded contortion of the strata. It is in the woods about 450 feet N. of the road. In the face exposed, the cleavage is also seen to differ from the stratification and form an angle with the beds. (See Plate 4.)

Near Jordan Church there is a slate quarry belonging to the estate of Joseph A. Good. The quarry has not been worked since his death, about two years ago, and is now full of water.

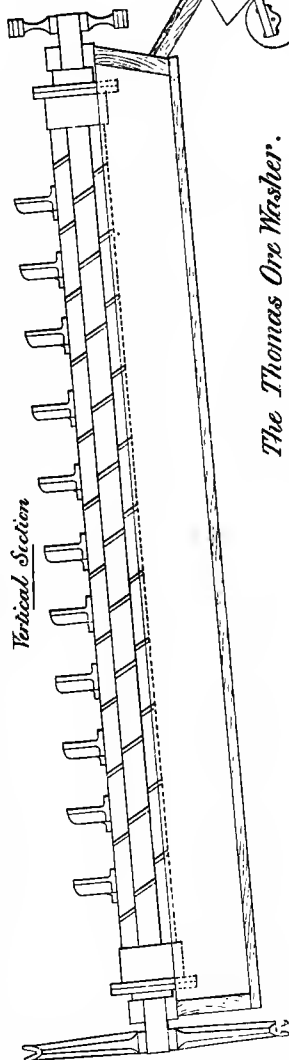
Second Geological Survey of Pennsylvania
J. P. Lesley, Director.



Horizontal Section.



Vertical Section



The Thomas Ore Washer.

PLATE V.

The slate obtained was used for roofing, and from the specimens seen appears to be of a fair quality. The quarry is said to be 65 feet deep, and was worked for 30 years, supplying a large part of the neighborhood with slate. There are several other places in the district visited, where small quantities of roofing slate have been obtained, but none of them appear to have been very successfully operated.

Just south of Walbert's Station, on the Catasauqua and Fogelsville railroad, there is a cut in drab colored slate; the direction of the bedding and cleavage are identical, being S. 61° W., but the amount of dip varies; that of the bedding being 32°, and the cleavage 53°. As will be seen from the map the general direction of the slate dip is south-east, but this may in a great measure be due to cleavage, and it will require a much closer examination than there was time for, during the past season, to ascertain if the slate ridge running north of Fogelsville forms another synclinal or not.

CHAPTER XL

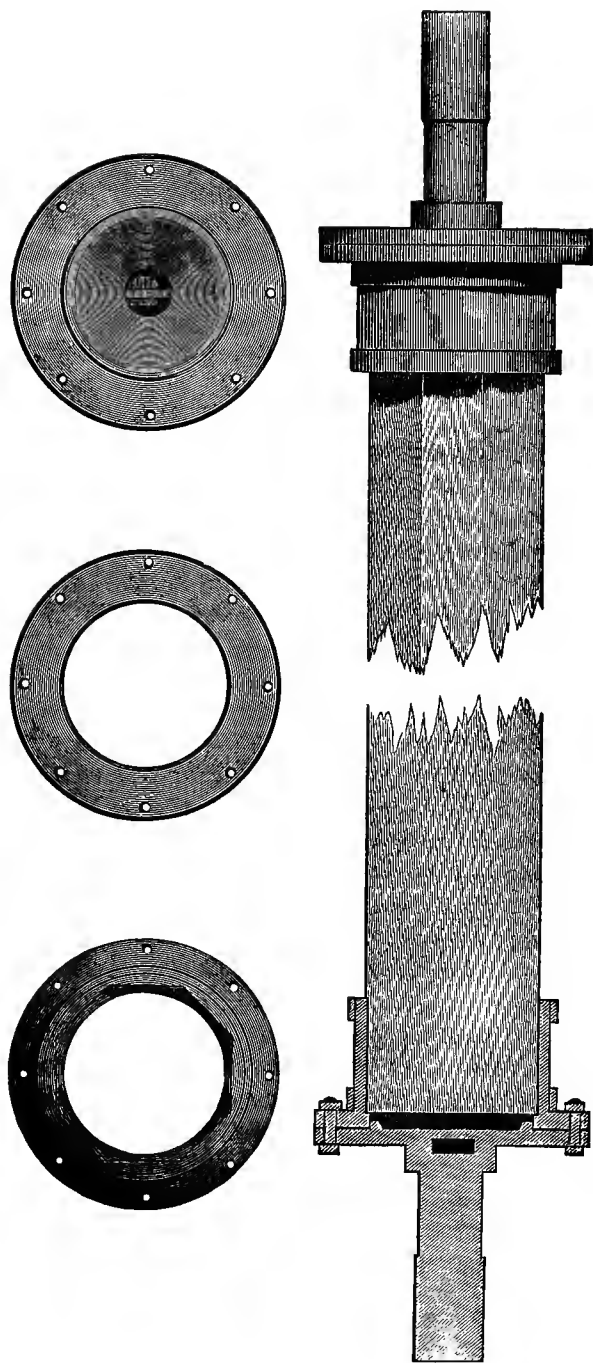
Mining and Washing of Brown Hematite Ores in Lehigh County.

The method of mining the brown hematite ores in Lehigh county is universally by means of open pits, in this respect differing from the method employed along the Lehigh river in Northampton county, where underground workings are more common.

In Berkshire county, Massachusetts, the plan of open workings, formerly so common, has been abandoned, with few exceptions, for underground workings; thus saving the very expensive stripping formerly necessary. It is a question to be considered separately for each mine, whether it is cheaper to work underground or in open quarries.

As a rule, when a pit is opened horses and carts are employed to carry the ore to the washer. For this purpose, as the pit is worked deeper, a road has to be left by which the horses can ascend. As a general rule, everything is removed. The top earth or stripping is washed or not, according as it does or does not contain sufficient ore to pay for this operation. The amount of stripping to be removed before reaching pay ore varies very

PLATE VI.—THE MICKLEY GUDGEON.



much in different localities. In some places but a foot or two of top earth has to be taken away, while in other localities 40 to 50 feet of stripping have to be carted off. After the ore proper has been reached there will be found places in the pit so lean in ore that it does not pay to wash them, these are as a general rule left standing unless paying ore is found underneath them (as is generally the case) when the overlying barren earth is then of course taken away to get at the ore. It is questionable whether the method adopted by the Thomas Iron Company (under the general superintendence of the Messrs. Mickley) is not the best. They take everything out of the pit whether ore or barren clay; in this manner equalizing the cost of extraction and rendering it unnecessary to expend a large sum of money at one time to remove the earth containing no ore. Pickaxes and shovels are alone employed to extract the ore, gunpowder never being needed to remove either the clay or soft slate with which the ore is associated. The ore after being loaded on to wagons is carried to the washer, there to be separated from the clay, slate and boulders of sandstone associated with it.

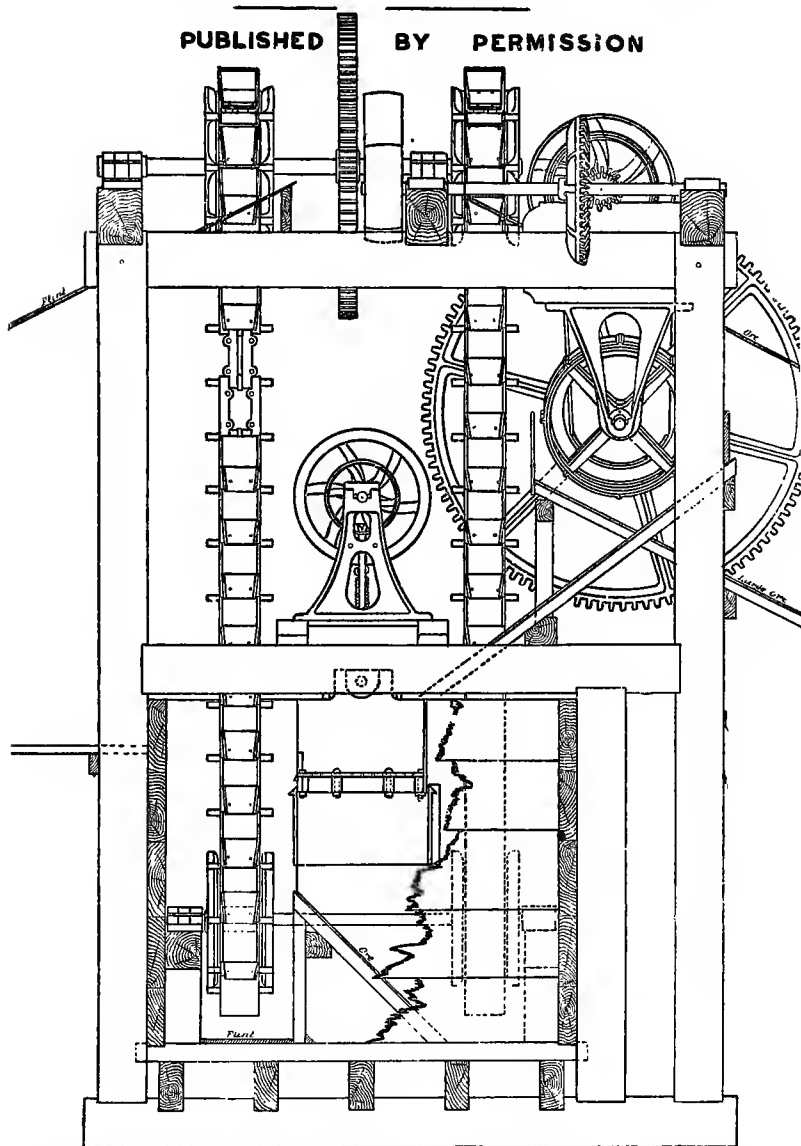
The washers in use are of three kinds, being constructed either with a single horizontal shaft, or on Thomas's patent with two shafts, or on Bradford's patent.

The only difference between the two former consists in having two shafts instead of one, by which the quantity of ore washed is much increased. To avoid repetition only the Thomas washer will be described, more especially as the washer, with a single shaft, has been almost entirely supplanted by the other. The Thomas washer consists of two shafts 20 to 24 feet long armed with teeth which are set at an angle as in Plate 5.

The shafts have an inclination of about 12 to 14 inches in their entire length. They are driven by steam power which is connected with the lower end of one of the shafts by an endless chain. The other shaft is made to revolve by geared wheels attached to the upper end of the shafts. The ore is carried to the upper end of the washer by the teeth and passing over a sieve it falls into a wheelbarrow. These washers have all been constructed until recently with wing-gudgeons inserted into the end of the shafts, the result being that the strength of the shaft was impaired. In addition to this the wood of the shaft soon rots

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BRADFORD'S IRON ORE AND FLINT SEPARATOR
END ELEVATION



PLATE VII.

where the gudgeons are inserted, from being exposed to the continual action of air and water. It is not long therefore before the gudgeons work loose and have to be reset. To do this so that the reset gudgeon shall be true is a very difficult matter and it is probably no exaggeration to say that seventy per cent. of them are not true, the result of which is that in a very short time the boxes and the shafts are cut and also that it requires an increase of power to work the shafts. In order to obviate these difficulties Mr. J. W. Mickley, of Hokendauqua, has invented a gudgeon, a wood cut of which is subjoined. (See plate 6.)

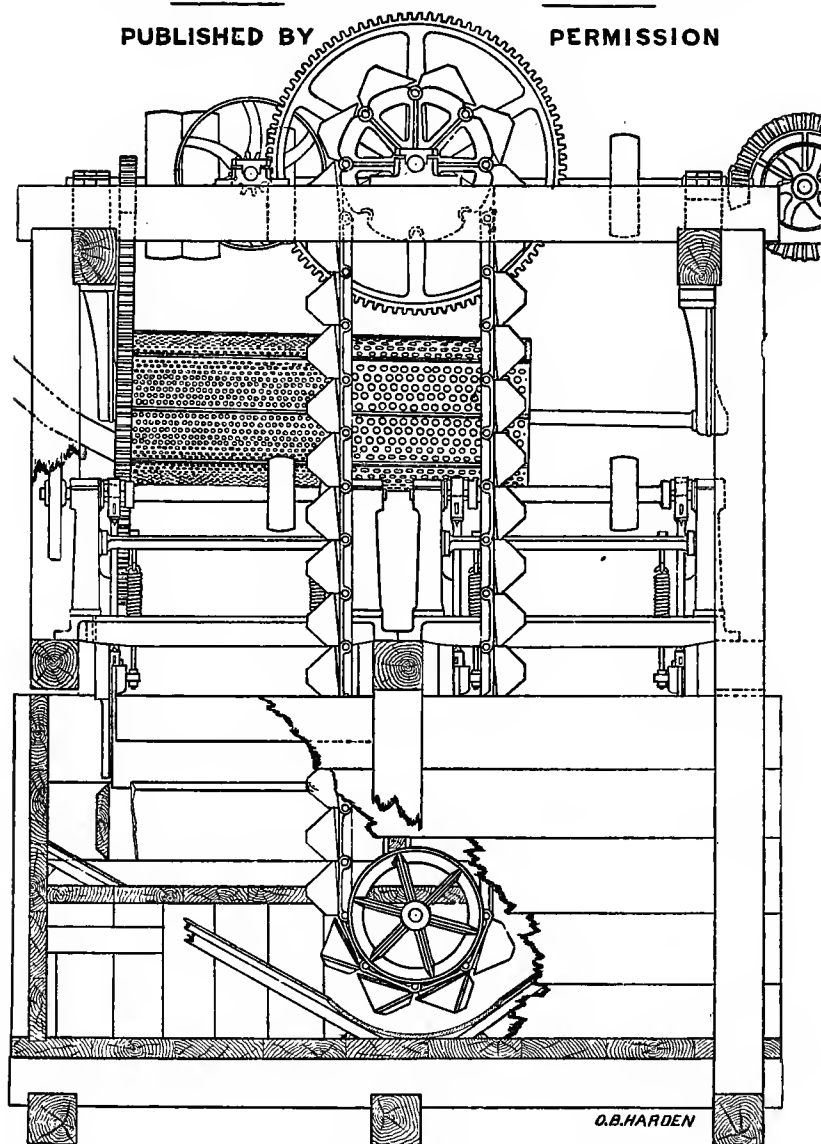
This has a sleeve fitting over the end of the shaft and thus does away with the necessity of cutting a slot in the end, and in this manner greatly increases the strength of the shaft. It can be placed so as to be true much more readily than the ordinary gudgeon and it can be replaced by any man who can draw a bolt. In case, too, of fracture it is evident that the shaft will have to break as the flange and socket cannot. The washer is erected on a frame-work ten to twenty feet above the ground in order to have an abundance of distance to dump the ore, gravel and clay.

The method of washing the ore is as follows:—The ore is dumped from a cart or car between the two shafts at the lowest end; care being taken to have an abundance of water to wash away the clay as it becomes disintegrated by the teeth of the shafts. For this purpose a wooden gutter, perforated with holes, is carried the entire length of the washer, the amount of water being diminished at will by stopping up the holes. The ore, being heavy, sinks to the bottom of the trough underneath the shafts, and is carried up to the top of the trough by the teeth which are set at such an angle as to accomplish this purpose. The clay, being light, is floated off by the water at the lower end of the trough, and is carried in gutters on a trestlework to the mud-dam. Where the clay is very refractory it is apt to cake, and forms balls a little larger than a man's fist. When it is so tough as not to separate readily from the ore, some of the teeth on the shafts are reversed, so as to retard the passage of the ore through the washer, and to give the knife-edges of the teeth a longer opportunity to cut through the clay. The amount of ore washed in a day varies very much, being between 15 and 35 tons; the average being 20 to 25 tons.

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BRADFORD'S IRON ORE AND FLINT SEPARATOR
SIDE ELEVATION



PLATE VIII.

Bradford's washer is used by the Thomas Iron Co. at two of their mines, and the Crane Iron Co. at one mine. In this washer the ore and rock, after being divided into two or more sizes by being passed through the rotary sieve, then falls into a jig where the ore, flint and slate are separated according to their various specific gravities, the ore being the heaviest going to the bottom. In order to make the jig continuous in its action, self-acting rakes are arranged by which the slate and flint are raked off the surface. These are then hoisted by a Pater-noster chain to be dumped on an inclined platform. This washer apparently works very well for the separation of flint and ore; it does not however separate the ore so well from the damourite-slate. This failure was apparently due in part to a lack of sufficient sieves for sizing. Partly to the very light character of a portion of the ore mixed with the slate, so that the difference in the specific gravities of the two is not very great. Another defect of this washer is the comparatively small quantity of ore washed per day. (See plates 7 and 8.)

The following mines have, by an oversight, been omitted in their proper places:

Thomas Iron Company's Mine, No. 71. Not being worked when visited, its character is apparently identical with that of Frank S. Lichtenwallner's, No. 25.

John Sharp's Mine, No. 53. This mine has not been worked for a long time, and it was impossible to see anything in it.

T. Smoyer's Mine, No. 89. This consists of one small opening which has not been worked for some time, and the sides are too much washed to see anything.

All mention of the following mines of magnetic iron ore has been omitted, although they are on the map, it having been thought best to describe them in connection with the geology of the South Mountain.

No. 45. *Peter Kline's Mine*.

No. 46. *Thomas Iron Company's Mine*.

No. 47. *John Wetzel's Mine*.

No. 48. *George Grice's Mine*.

No. 86. *Daniel Desch's Mine*.

No. 87. *Jacob Newmoyer's Mine*.

No. 88. *Unknown owner's Mine*.

Note by the State Geologist.

The map, which accompanies this report, was originally constructed by Mr. Ellis Clark, Jr., with great care, on a scale of 400':1", occupying the whole or parts of 42 sheets of plotting paper; and reduced by him to a scale of 1,600':1" on 6 sheets of plotting paper; the sheets, after being inked, were photographed and transferred to zinc by Mr. Wenderoth, of Philadelphia. The saving of time and labor by this process is a capital consideration in the economy of the survey. But its chief value consists in the direct passage of the work, in its integrity, from the pencil of the field-worker to the eye of the reader, without the intervention of lithographers, who are better skilled indeed in drawing, but are ignorant of topography and geology. What the map loses in beauty, then, it gains in accuracy, being a fac simile of the office work of the assistant. The exhibition of the cross bars of the plotting paper is not to be accounted a defect, but an additional advantage to the reader, since it places a universal scale at his disposal for measuring distances in all parts of the district represented, and shows the size of each ore bank without reference to the text. Each cross bar measures 1,600 feet, $3\frac{1}{4}$ cross bars 5,200 feet, or nearly a mile. The field-work of all the assistants on the survey is done on an original scale of 400 feet to the inch, and afterwards reduced.

The numbers on the map are those of the principal ore banks in the order in which they were visited; and the same numbers are given in the pages of the text, together with the names of the owners or lessees of the banks. The smaller and less important are not numbered, but are located accurately on the map. To have re-arranged the numbers in their geographical order would have involved the re-drawing of the map, and a delay in the publication; and any new openings to be hereafter inserted and reported, would disarrange the order of numbers, unless fractional numbers were employed, which would break the system in another sense.

For the eye of a geologist the map needs no coloring, because the strong shading, produced by the close proximity of the ten

foot contour-lines on the hill-slopes and mountain-sides, is a sufficient guide to the areas occupied by the Hudson River Slates (No. III) in the north, and by the Potsdam Sandstone (No. I) and the underlying gneiss rocks of the South Mountain and Lock Ridge. All the rest of the map is visibly a rolling plain of Limestone (No. II,) where the contour-lines lie wide apart.

The contour-lines represent the curves which the edge of an ocean would make if the district were depressed to depths or 300', 310', 320', 330', 340', &c., &c., up to 1,000' below its *present* elevation above tide. In this case the Atlantic ocean would submerge southern New Jersey, and send a bay up the Lehigh Valley, having its south shore at the foot, or on the slope, or the South Mountain, and its north shore against the slate hills. Each hundred foot contour-line is so marked in several places on the map; and in some parts of it the heights of a series of contours are so marked, for the convenience of the reader.

Arrows will be noticed in many places. They show the *dip* of the Limestone, Slate or Sandstone beds, as nearly as it could be determined by compass. The *strength of the dip* is marked in degrees alongside of the arrows, 0° being horizontal and 90° vertical. A clinometer was used to measure the dip; but owing to the thousand minor disturbances to which the region has been subjected, the pressed and faulted condition of the surface rocks, and the predominance of *cleavage-planes* both in the limestone and in the slate layers, it is not always possible to determine absolutely what the dip is, how much, or in what direction. The dips marked on the map are those selected as the most reliable out many hundreds of observations more or less untrustworthy. There are very few good rock exposures in the district, much of the drainage being by caverns underground, and the streams flowing through wide shallow vales of limestone land. Even in the slate hills, where the ravines are sharp, good exposures are not as numerous as in countries of sandstone and shale less cross-cleft by pressure. The rocks of this district are nearly the oldest in the world known to geologists; and they have been so repeatedly fractured, in different directions, and distorted by pressure (from the south-east,) that they weather on hill slopes into small rhomboidal blocks, fall and

slide down, and cover up such outcrops as vegetation might otherwise leave exposed.

Enough indications of dip are given, however, to show to the intelligent reader how the outcrops of the formations, constituting the great limestone mass of No. II, run from south-west to north-east across the map. It is not desirable to furnish any information of a speculative character in these reports. Nothing but reliable facts can be of any real use in a survey of this sort. Therefore no attempt is made to show on this map *supposed* belts of single rocks, or groups of strata. Indeed this would be dangerous. Professor Prime is occupied this year (1875) in mapping the country between this map and the Lehigh River. The map to be published next winter will be a continuation eastward of the one published now. The party is trained to the work, and has better instruments and more experience. The knowledge obtained by the work of 1874 will increase the ability of the observers to understand the outcrops as they approach the river, and a very careful and accurate section along the bluffs on both sides of the Lehigh will probably throw a flood of light upon the obscurities of the country between Fogelsville, Emaus and Albertis. The map will also be continued westward towards Reading, where a section along the Schuylkill River will read us a new lesson.

When it is considered that this extremely important belt of iron-ore-bearing country has never before been carefully studied on an instrumental system, we may hope to obtain a good understanding of it by continuing the investigation from end to end, in spite of the acknowledged difficulties. These are in fact very great, and increase in moment as the study of the district advances. It seems a very easy matter to obtain the knowledge which we want in so open, well formed, almost level valley, bounded on one side by a mountain faced by a well-known rock *underlying* the limestones, (Potsdam S. S., No. I,) and on the other by hill slopes of unmistakable *overlying* slates, (Hudson River, No. III.) But what seems a facility turns out to be the principal difficulty. What seems so smooth and regular a surface conceals one of the most contorted, twisted, fractured cleft, plicated, complicated and even overturned set of subsoil rocks in the world. Besides the three or four large and pretty

regular anticlinal waves which issue from the South Mountains and the hills of Easton and strike diagonally westward up the valley toward Port Clinton on the Schuylkill, there are hundreds of sharp little rolls which seem to defy classification, and most of these are almost entirely concealed by a top covering of mouldered limestone clay, soil and vegetation. Sink-holes are numerous; and the whole underground is a labyrinth of caverns, dissolved out of the limestone formation by rain water charged with carbonic acid, the great agent in the erosion of the United States.

It is not traveling outside the record to allude here to the greatest of all geological phenomena—the lowering of the old surface of the earth to its present height above tide. The people of Lehigh and Northampton counties ought to be made aware that where their fertile fields now are was once, in far back geological ages, a country as high in the air as the plateau of Thibet is now. On the top of their limestones No. II, and their slates No. III, were piled, in successive stories ascending, the sand-rocks of the North Mountain (No. IV), the red shales hydraulic limestones, sand-stones and olive shales (Nos. V, VI, VII and VIII) of the Stroudsburg and Lehigh Valley, the red and white sandstones (Nos. IX and X) of the Mauch Chunk Mountain, the red shale (No. XI), and the coal measures, —to a height of at least 30,000 feet. The proof of this is perfectly plain and easy. All that pile of old country has been in lapse of almost infinite ages frittered away by snow, ice and rain; the softer rocks giving away first and letting the massive sandstones down; these being then broken and rolled to gravel and sand, and carried into the ocean. The whole tide-water country of the United States has been made out of that old mountain highland, the remnants of which, our Pennsylvania mountains, stand witnesses of the operation; one which is still going on. All the watercourses tributary to the Delaware and Lehigh Rivers are still busily engaged lowering the surface of Lehigh and Northampton counties (and all other counties in the State) to a level still nearer that of the surface of the ocean.

But the principal agent in this great work has been *rain water* charged, as it always is, with carbonic acid, *dissolving the limestone formations underground.*

The cutting down of the surface by brooks and rivers is slow work. This work has in all ages been hastened by the simultaneous hollowing out of a labyrinth of caverns, the roofs of which fall in finally and successively, letting down the sand and shale formations, and intensifying the action of rivers. The operation of this agency can be best studied throughout the blue-grass country of Kentucky and Tennessee, where it is easy to see how the edges of the coal fields have gradually in this manner been set miles asunder; and in the interior limestone valleys of Pennsylvania and Virginia, such as Sinking Valley; but it can be studied anywhere in the Easton, Reading, Lebanon and Cumberland Valley just as well.

Three dates are possible: First, the date of the beginning: the end of the Coal Era. For no one doubts that every coal bed was made of growing plants on nearly a dead level, and close to tide level. Therefore the great elevation of the United States Highland must have happened after the last coal bed was made.

Secondly the date of the New Red: before which a great part of the work must have been accomplished; for the New Red rocks were evidently deposited in an estuary, south of the South Mountains and north of the Philadelphia hills; and they rest on the worn away edges of the limestones No. II. Now the New Red rocks are no where seen *north* of the South Mountain range, even in the open place opposite Lebanon, where the top surface of New Red is at present several hundred feet higher than the present surface of the limestone; therefore, it is evident that the surface of the limestone valley had not yet been worn away deep enough to allow the waters of the New Red to flow over it. It is plain that the surface of the Allentown-Reading-Lebanon Valley has been worn down at least 1,000 feet since the date of the New Red. And there has been abundant time for a much greater waste; for since the New Red rocks were carried up out of their water bed, all the Cretaceous and Tertiary formations of southern New Jersey, Delaware, and the Southern States, have been deposited.

The third date is the glacial epoch; which was not known in this part of the State until recently. The marks of the great ice-cake were noticed nearly forty years ago on the Sum-

mit of Penobscot Knob overlooking Wilkesbarre ; on the crest of Locust Mountain west of Ashland ; and in the notch at the top of Peter's Mountain north of Harrisburg ; but these marks were ascribed to water. Agassiz showed, and everybody has become convinced now, that they were made by ice, which flowed, in a sheet several thousand feet thick, southward, over our mountains, just as ice now flows over Greenland. Recently a *glacial moraine* has been found at Franklin, New Jersey, opposite the celebrated zinc mines. And this spring (1875) Mr. Chance has mapped what seems to be a similar moraine behind the Lehigh Water Gap ; near where Mr. C. E. Hall has just found (July 10, 1875,) the evident work of glacial ice, *pushing over all the edges of the (Clinton) slates towards the gap*; and upon the broken edges lies a genuine top-dressing of glacial clay and boulders (*till*.) Mr. Prime has wisely said nothing in his report about his observations of supposed glacial drift in his district, because so difficult a subject should not be more than alluded to during its investigation, and his work of 1875 between the Fogelsville and Emaus country (represented on our map) and the river at Allentown and Hockandaqua, and so on to Easton, will probably give him facts enough to base some judicious conclusions upon in his next report.

We are therefore not yet in a situation to say how far the *surface iron ores* are connected with the glacial drift, or whether any real connection at all exists between them.

Mr. H. M. Chance has prepared elaborately surveyed and plotted contour-line maps of the three principal gaps through the North Mountain, by which the waters of the Delaware, Lehigh and Schuylkill Rivers issue. Although these are in Professor Prime's district and might be expected in this book, yet it seems more desirable to keep all that concerns the Brown Hematite Iron Ore-beds of the limestone together. The rocks of the North Mountain belong to a later and different geological system. The preparation of Mr. Chance's maps for the press would delay the publication of this report ; and it is moreover hoped that the Wind Gap and the Swatara Gap may be added to the series to make our sections of the Upper Silurian Rocks more complete, and shed light on the origin and growth of our mountain gaps.

While the above pages were going through the press, the discovery was made of what seem to be Chazy fossils along the northern border of the limestone land. It looks as if the Trenton limestones proper (with the Bird's eye and Black river subdivisions of the group) were really wanting to this district; in other words, all Prof. Rogers' *Matinal* limestones; leaving nothing but the *Auroral* limestone group (which underlie in other parts of the United States the Matinal) to occupy the ground. The breccia or angular pudding-stone limestones seen along the edge of the slate country, show that there was a coast of dry land close by. Constant changes of sea level, we know, took place in those early ages. In Canada and northern New York the sea-level rose after the Calciferous and Chazy rocks were deposited, and overflowed great regions of land made up of older rocks. On these older rocks the horizontal beds of the Trenton age (first and lowest Bird's eye, then Black river, and lastly Trenton proper) now lie, either in broad sheets, or in fragmentary patches, the rest having been in lapse of time eroded away; and therefore in all parts of the United States one may look for a break in the series at the top of the Chazy. In Lehigh county, Pa., the Chazy seems to have been left dry land for a long while (during the Trenton age) and then to have been again overflowed, allowing the Utica, or the still higher Hudson River slates to be deposited directly upon it. A different set of animals lived in the muddy limestone waters of the Trenton age, from what had lived in the magnesian lime waters of the Calciferous age. So that both the chemical character of the limestone and the forms of animal life found in it, taken together, enable us to determine the age of it, and to predict from what is known of it elsewhere, what its minerals will be like.

To assist the general reader the following table of rock formations is appended:

Table of Rock Formations

arranged in the order of the ages from above downwards, as they are recognized in America, and according to the present state of our knowledge.

The *Recent* river muds and ocean sands and gravels.

The *Glacial* drift, wherever it exists

The *Tertiary* sands, clays and marls of Southern New Jersey and other Tide Water States, the Missouri River Region, the Rocky Mountain Parks, the Pacific Coast ranges, and the Central British Possessions.

The *Cretaceous* shales, sands, green marls, and pottery clays of Middle New Jersey and the Southern States, the Mississippi and Missouri regions, Rocky Mountains, &c. The chalk of Europe and of Western America belong to this age.

The *New Red* rocks of the Connecticut River Valley, of Middle New Jersey, and of Bucks, Berks, Lancaster, York and Adams counties, Pennsylvania, continued through Maryland and Virginia, by patches, to the James River and Richmond Coal basins, and the Dan River and Deep River basins in N. C. The supposed bottom rocks of this age are found in Kansas and the far west, and perhaps in Greene county, Pennsylvania.

The *Coal* measures, anthracite and bituminous.

The Great Conglomerate, No. XII, of Mount Pisgah, called by Professor Rogers *Seral*.

Red Shale, No. XI, (*Umbral*) around Mauch Chunk.

White *Catskill*, No. X, (*Vespertine*) of the Second Mountain.

Red *Catskill*, No. IX, (Old Red of England) Pocono Mountain.

Chemung shales, (VIII, *Cadent*.) holding the oil-rocks.

Portage sands and shales, (VIII, *Vergent*.)

Hamilton black slates, (VIII, *Scalent*); streaks of coal.

Upper Helderberg limestones, &c. (VIII, *Post Meridial*.)

Oriskany sandstones (VII, *Meridial*) Stone-Ridge, Lehigh Gap.

Lower Helderberg cement layers, &c., (VI, *Premerial*.)

Niagara limestone (VI) at Walpack Bend of Delaware river.

Clinton Red Shales (V, *Surgent*); with fossil ore.

Medina red sandstones (IV); with rock ore.

Oneida Conglomerate (IV, *Levant*.) making the ribs of the North or Kittatinny Mountain.

Hudson River Slate Group (III, *Matinal*.) constituting the northern half of the great valley.

Trenton Limestone Group (II,* *Matinal*.)

Calciferous or *Magnesian* Limestone Group (II, *Auroral*.)

Potsdam Sandstone and Slate (I, *Primal*.) resting on the gneiss and slates of the South Mountain in Pennsylvania, but consist-

* II being the original, and *Matinal* being a subsequent arrangement.

ing of many thousand feet of conglomerates, sand rocks and slates along the western base of the Blue Ridge and Black Mountains of North Carolina, and there called *Chilowhee* and *Ocoee*.*

All the above XII formations, with the coal measures at the top, together form the Paleozoic System; or Older Secondary. They measure forty thousand (40,000) feet in thickness in Pennsylvania; and in the bottom layers was once thought to be the beginning of life on the planet. But of late years multitudes of older forms of life have been discovered in the following three formations lying underneath the Potsdam, viz:

The <i>Menevian</i> .	}	Lower Cambrian System of Wales.
The <i>Harlech</i> .		
The <i>Llanberis</i> .		

Menevian fossils have been discovered in a thick formation of the same age at Braintree (near the Quincy granite quarries of Massachusetts,) at St. John in New Brunswick, and at St. Johns in Newfoundland.

Underneath the Potsdam in Canada, at Hastings and other places north of Lake Ontario, lie three great systems of rocks, of immense thickness, and almost wholly destitute of the remains of life forms. And to these belong the rocks of the three great mountain ranges of the north, viz:

The Green mountains of Vermont,

The White mountains of New Hampshire, and

The Laurentian mountains of Canada; but the exact order in which their innumerable beds of various minerals must be placed (mica slates, talc slates, serpentines, chlorite slates, quartz rocks, conglomerates, limestones, graphites, iron ores, traps, porphyries, gneisses, granites) has not yet been made out.

The original names (given by Dr. Hunt) *Laurentian* and *Huronian* have been accepted by all geologists, the Laurentian being the lowest and oldest system of rocks known. But whether the Green Mountain system (*Huronian*) be above or below the White Mountain system (*Montalban*)† is not yet settled.

* Dana's Manual, p. 163 (1874), makes the *Chilowhee* only to represent the Potsdam; and the *Ocoee* to represent the next lower (Cambrian) system.

† Dr. T. Sterry Hunt's name for this system, not yet accepted.

The section along the Schuylkill, above Philadelphia, shows about 20,000 feet of these rocks; and the serpentines and talc slates of the Huronian or Green Mountain series seem to be on top; the gneisses of the White Mountain series (in the Park at Philadelphia) at the bottom.

The Laurentian system is represented by the Highlands of New York and New Jersey; the Easton and Allentown and Reading hills; the South mountains of Carlisle and Chambersburg;* and the Blue Ridge of Virginia. Only the top layers of this great system are visible in the district of this report; and the Potsdam lies unconformably and directly upon them, no ocean having been here during Menevian, Huronian, Montalban and Norian (Upper Laurentian) ages. Any discussion of these points would be out of place in this report, which does not touch upon the *foundation* rocks underneath the dolomites and sandstone of the valley. What is known on the subject will be told in the reports of other districts occupied principally by those rocks.

The use in these pages of the terms *Upper* and *Lower Silurian* is merely for convenience. Their proper use, and that of the terms *Upper* and *Lower Cambrian*, will be discussed elsewhere.

The above table of formations is here given only for convenient reference by the reader, and to show how exceedingly small a proportion of the whole 100,000 feet of known strata in the earth's crust occupies the rolling surface of Lehigh county.

* In 1872 the writer made a section of 12,000 feet of slates and quartzites, holding iron ore, in the heart of the South Mountain mass, a map of which will be published in the Reports of Progress of the Survey for 1875. Dr. T. Sterry Hunt has recently (Aug. 1875) made a reconnaissance from Gettysburg to Chambersburg, during which he thought he recognised the old orthoclase-porphyrries of the Huronian of Missouri, and of eastern Massachusetts and Maine. Two belts of these red stratified porphyries, with argillites, diorites, epidiosites and chlorites, intercalated as usual; and two belts of Primal sandstone, unconformable upon the former. The conglomerate beds of the overlying Primal hold pebbles of Huronian.

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ERRATUM.

By an oversight in this report the analysis of brown hematite iron ore from the Thomas Iron Co.'s Mine, No. 52, was erroneously credited to Hensinger & Saul's Mine, No. 54.

Second Geological

of

PENNSYLVANIA

1874

A MAP IN 10 FOOT CONTOUR

SHOWING THE RAILROADS

OF

BROWN HEMATITE

IN A PORTION OF

LEHIGH COUNTY

By Ellis Clark Johnson

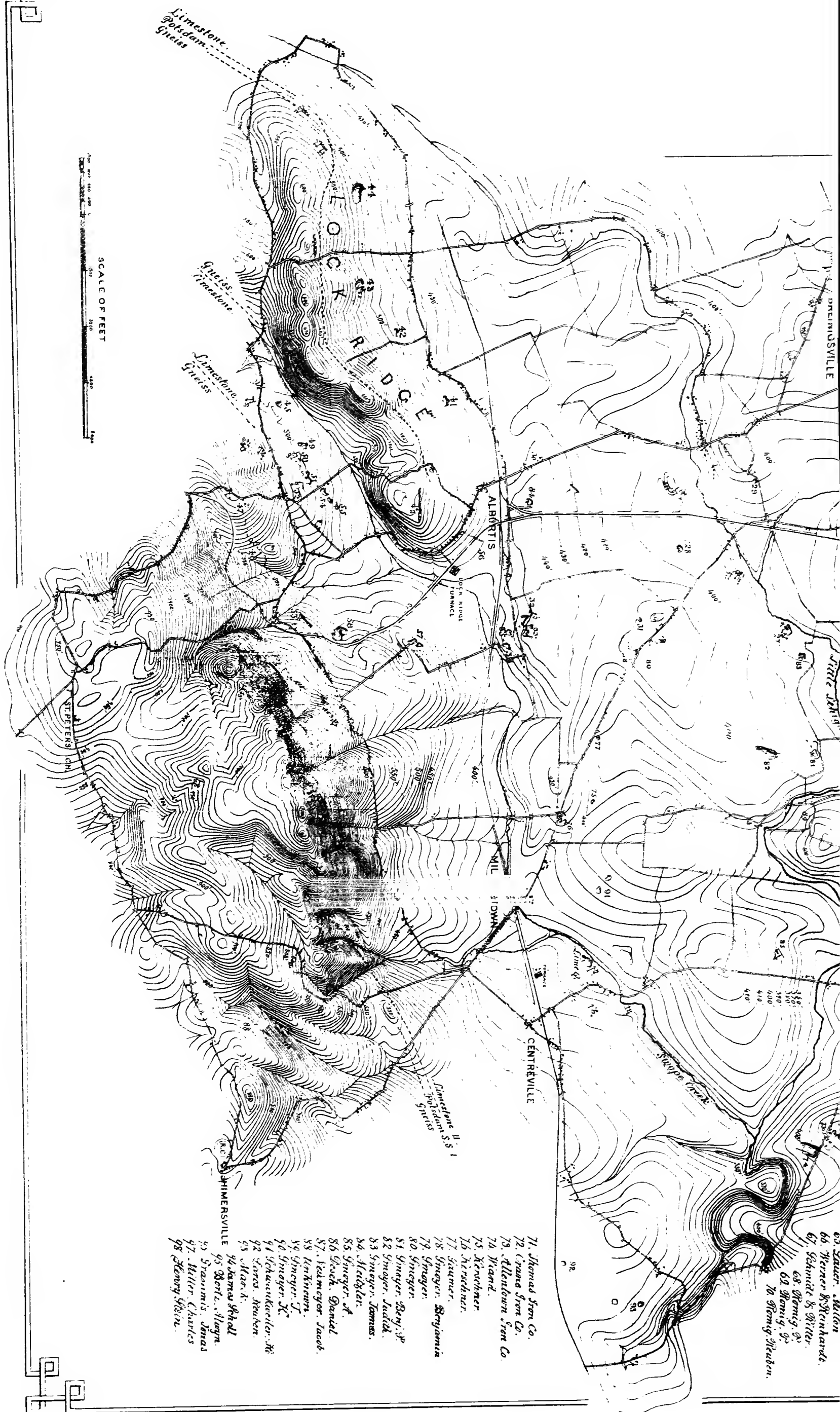
TO ACCOMPANY REPORT OF

BY FREDERICK PRATT

ASSISTANT GEOLOGIST

1. Sitzenberger, H.
2. Sichtenwaller, L.
3. Laros, Jesse.
4. Laros, Jesse.
5. Plene, Henry.
6. Moyer.
7. Tremlich & Sichtenwaller.
8. Steininger, Jacob.
9. Miller, Charles.
10. Steininger, Jacob.
11. Gehall, J. D. and Co.
12. Gramms, Jones.
13. Bortz, A. & Koch W.
14. Bortz, Allwyn.
15. Hammes.
16. Smith, J. S. D. (Schlag).
17. Breinig, Francis.
18. Fogel, W. B.
19. Breinig, Thomas.
20. Martin, Oliver.





SCALE OF FEET
0 1000 2000 3000 4000

63. Zaun, Milton
66. Werner & Reinhardt.
67. Schmidt & Witt.
68. Gerny, Jr.
69. Gerny, Jr.
70. Gerny & Reuben.
71. Thomas Iron Co.
72. Evans Iron Co.
73. Henden Iron Co.
74. Haden.
75. Kerschner.
76. Kerschner.
77. Zaun.
78. Gerny, Benjamin
79. Gerny.
80. Gerny.
81. Gerny, Gerny, Jr.
82. Gerny, Judith.
83. Gerny, James.
84. Haden.
85. Gerny, Jr.
86. Gerny, Daniel.
87. Kerschner, Jacob.
88. Kerschner.
89. Gerny, Jr.
90. Gerny, Jr.
91. Gerny, Jr.
92. Gerny, Jr.
93. Gerny, Jr.
94. Gerny, Jr.
95. Gerny, Jr.
96. Gerny, Jr.
97. Gerny, Jr.
98. Gerny, Jr.
99. Gerny, Jr.

